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CONTENTS.

EDITORIAL:
Municipal Lighting Plant Suggested for New York 949
Haphazard Engineering 949
Gas Engine Performance in Generating Stations 950
Resignation of Chief Engineer Parsons 950
Good Advice to Be Accepted with Reserve 950
The Electric Furnace in the Production of Iron and Steel 951
A Magnetomotive-Force Meter 951
Telephone Engineering—XIII, by J. C. Kelsey 952
The Unipolar Dynamo 954
Dinner of the Carnegie Veterans' Association 954
The La Goule Hydroelectric Installation, by Franz Koester 956
The Madison Branch of the American Institute of Electrical Engineers 959
For a Municipal Lighting Plant in New York City 959
World's Water Power 959
Commercial Aspects of Telephone Line Protection, by Kempster B. Miller 960
Municipal Electric Lighting in Great Britain 962
Royal Favors to Distinguished Scientists 962
Northwestern Electrical Association 962
The Convention of the Interstate Independent Telephone Association 963
Banquet of the New York Edison Company Agents and Inspectors 963
Convention of the National Electric Light Association 964
Extent of Telephone Service 964
Mr. William Barclay Parsons Resigns from the Rapid Transit Board 964
Grounded Transmission Mediums—III, by J. Stanley Richmond 965
Problems of Heavy Electric Traction, by O. S. Lyford, Jr., and W. N. Smith 967
Electrical Notes from Europe, by C. I. Durand 971
Journal of the British Fire Prevention Committee 973
American Association for the Advancement of Science 973
Electricity in Farm Work 973
BOOK REVIEWS 973
Traffic in the Subway During the First Month of Operation 974
Some Difficulties in Getting On, by James Swinburne 975
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 978
ELECTRICAL PATENTS 980
The Electrical Fire Hazard, by C. J. H. Woodbury 981
Evening Lectures in Electricity at the Polytechnic Institute, Brooklyn, N. Y. 982
INDUSTRIAL SECTION:
Telephone Equipment Made by the Wotton Electric and Manufacturing Company 983
Specialties for Telephone Service 985
Telephone Apparatus Manufactured by the Williams Telephone and Supply Company 986
The Measured Service Company's Apparatus 986
Baum Steam Separators 987
New Boiler Flue Cleaner 987
Numbering Metal Parts 988
Sound-Proof Telephone Booths 988
CURRENT ELECTRICAL NEWS 989

MUNICIPAL LIGHTING PLANT SUGGESTED FOR NEW YORK.

The commissioner of water, gas and electricity of Greater New York has made contracts with the local company for electric lights at a rate somewhat less than that asked by the company, though greater than the rate contended for by the city. For some time past the city and the company have not been able to come to an agreement, but the matter is now settled for a while, at least. In view of this action it is not easy to see the utility of the resolution passed by the Board of Apportionment, at the instance of Controller Grout, directing the corporation counsel to draw up a bill authorizing a municipal lighting plant. This bill has been characterized as a club to be held over the lighting company, and even if it should be passed its usefulness in this respect, for the present at least, is gone. We hope the bill will be defeated, first, because we do not believe in the principle involved, holding that it is the function of the municipal government to govern the city and the more closely it follows this course and the less of the actual work of the city it is obliged to do the better. Further, we believe a municipal lighting plant would be an expensive luxury. That it would of necessity be uneconomical because it were a municipal plant does not follow, but our experience with municipal plants in this country has been unfortunate and we see no reason for believing that a plant in New York would be operated to a better advantage than has been the case elsewhere. The experiment would be costly and not without a good deal of risk.

HAPHAZARD ENGINEERING.

The valuable contribution of Mr. Kempster B. Miller in this issue, bearing upon the important problem of protection of telephone apparatus and telephone lines from damage by foreign currents, illustrates very clearly a principle, the application of which is highly essential in all electrical arts. This is, that a conservatism so great as to cause an engineer to design strictly in accordance with the established principles of previous times, does not contribute to a distinct, safe and useful progress. It is for some such reason as this that certain people are still voting for Andrew Jackson. Likewise this is why the boy in southern Indiana, going to mill with a little corn, puts it in one end of the bag, and a stone in the other, to make it balance across the horse's back. To him it is sufficient to know that his father, and his father's father before him, did it that way.

The Importance of Proper Protection.

In so important a matter as the protection of telephone lines and apparatus, much has been accomplished, but there has seemed to be a tendency to adopt forms and arrangements on the basis of previous practice rather than from a thorough examination of the situation to extract the reasons, and an effort toward logical thinking to a conclusion upon the reasons. It seems highly probable that the whole field of telephone construction method might bear review to see whether some of the elements of wire distribution may not be heirlooms of telegraph antiquity rather than the survival of the fittest ways. In the simple matter of spacing open wires certain distances apart on cross-arms, there has been little change since the early days of long spans, light poles, heavily loaded structures, and easily corroded wires. With all these elements changed and changing, one may wonder whether modifications might not be made with no sacrifice of safety and efficiency, and a distinct step taken toward that result so much to be desired—a substantial cheapening of line circuits.

GAS ENGINE PERFORMANCE IN GENERATING STATIONS.

An excellent opportunity was offered recently to compare the performance of gas engines in an electric lighting station with that of a similar equipment consisting of steam engines. Two of the plants operated by the Guernsey Electricity Company—those at St. Petersport and St. Sampson's—are operated, the one by steam, and the other by gas engines. In fact, the latter installation replaced a steam plant similar to that at St. Petersport. The two plants are situated equally favorably with regard to coal supply. At St. Petersport there are two seventy-five-kilowatt combined steam engine sets and two 180-kilowatt, triple-expansion steam engine sets, a condenser rated at 360 kilowatts, two water-tube boilers, a superheater, an economizer and a storage battery. At the gas-driven house at St. Sampson's, there are two 180-kilowatt gas engines with producers and a storage battery.

Tests have been made of the performance of these two plants, which show a decided advantage in favor of the gas engine. In comparing these figures it should be remembered that, although the units are of the same size, they are small. Another factor to be borne in mind is that the steam station was carrying a lighting load, while the gas-driven station carried a power load, for which purpose it had been erected. It is said that the total cost of the steam plant was $18,321, as against a total cost of the gas plant of $16,000. No allowance is made for buildings, foundations and unskilled labor.

The gas engines at the St. Sampson's station are of the four-cylinder, vertical type, and work on the Otto principle. Each is capable of developing 300 brake-horse-power on producer gas, at a normal speed of 250 revolutions per minute. The total cost of generating electricity at this plant during the six months ending with October, 1904, varied between 1.416 and 1.102 cents per kilowatt-hour. The cost per kilowatt-hour generated at the steam station during the same period varied between 1.5 and 2.13 cents per kilowatt-hour. The difference in favor of the gas plant during the time mentioned varied between 0.198 cent per kilowatt-hour and 1.026 cents per kilowatt-hour. The test of the gas engine at the St. Sampson's station showed that the total consumption of coal per kilowatt-hour was 1.67 pounds. This includes the coal used in the producer itself and in its auxiliary boiler. The consumption of gas per kilowatt-hour was 123 cubic feet. This test was made with a run of six hours, during which the average load was about 187 kilowatts.

These are excellent results and show a decided advantage in favor of the gas engine, under the conditions obtaining at the two stations. Of course, a better performance would have been obtained had larger units been installed, but in a plant of the size considered a larger size unit could hardly have been adopted. On the other hand, gas engines of larger size are coming into use and are giving satisfaction. A good deal of the prejudice which prevailed some years ago against the gas engine is being overcome, and its possibilities are being realized. To-day no engineer hesitates to employ the gas engine in an electric generating station if he thinks that, by doing so, he can obtain a minimum cost of generation.

RESIGNATION OF CHIEF ENGINEER PARSONS.

Mr. William Barclay Parsons, chief engineer of the Rapid Transit Commission, has resigned in order that he may devote more time and energy to his private practice. The construction of the New York subway, as first undertaken, is about finished, and the southern extension is nearing completion, so that the problems now presented are ones rather of construction than of engineering and design. Having, thus, practically completed his work in connection with the subway, Mr. Parsons doubtless desires to devote himself to solving new problems rather than to taking up the uninteresting task of supervising the use and care of a completed undertaking. In this field of labor he will find opportunity for exercising his high ability.

Mr. Parsons is comparatively a young man, being only a little over forty-five. He is a native of New York and a graduate of Columbia College. He has been associated with a number of important engineering works, and is chief of engineers of the New York National Guard, a position carrying the rank of brigadier-general. In resigning his old position, Mr. Parsons carries with him not only the esteem, but the gratitude of Greater New York. One may not say that other engineers might not have done as good work had they been appointed to his position, but we do not believe any one would have been more successful.

GOOD ADVICE TO BE ACCEPTED WITH RESERVE.

Upon a recent occasion Mr. James Swinburne, past-president of the Institution of Electrical Engineers, of Great Britain, gave an address to the student members of that society. Mr. Swinburne's addresses are always readable, for the sound, common sense which they contain and for their pleasing humor, so that the abstract of this address which we give on another page of this issue will be interesting to the young engineer, as it deals with the problems confronting the latter in his endeavors to get ahead. In this case, however, we do not think that Mr. Swinburne wishes to be taken literally—in fact, he himself says that he is not in sympathy with some of the advice which he offers. He says that the salary received is a rough estimate of the value of any man, and he classes the pure scientist, or, as he calls him, the raw scientist, as of little value in the world. While the first rule might be applicable in many instances, there would probably be as many exceptions, particularly with regard to the young men. Much of the pleasure of working will be lost if one holds strictly to the view that what he does has no other value than that of the pay received.

Mr. Swinburne is fond of contrasts, and we are inclined to think his low estimate of the value of the raw scientists is given to get even with those purely scientific men who decry practical application of their science. Such workers are, of course, indispensable since upon their disinterested work the future of engineering largely depends. It is true such men are usually found at the bottom of the salary list, but this is due to the scientific spirit which looks beyond immediate reward; while the world values everything by its immediate usefulness, and is willing to pay more for present luxuries than for future needs.

THE ELECTRIC FURNACE IN THE PRODUCTION OF IRON AND STEEL.

The report of the Canadian commission appointed to investigate the different electrothermic processes for the smelting of iron ores and the making of steel—an abstract of which appeared in the last issue of the ELECTRICAL REVIEW—is an exceedingly important document. The conclusions advanced in the report are only those which have been generally held by electrometallurgists, and which have been frequently put forward in print and at meetings of the engineering societies interested in the subject. It is, however, important to have the subject investigated, as was done in this case, by a disinterested commission, which not only looked into the different processes advocated by their inventors, but which, as well, visited a number of plants where certain of these processes are already in use. The committee was thus able to see the actual state of affairs at these plants, and to test the efficiency of several processes and examine the quality of the product.

The commission found that the electrical energy required to produce pig iron was about 0.53 horse-power-year. The furnace, however, was not built for the production of pig iron, and there is to-day no electric furnace producing this material commercially. To produce steel, starting from scrap iron, the energy required varied from 0.116 to 0.17 horse-power-year. There will, of course, be considerable variation in this since much depends upon the raw material and upon the quality of output desired. These figures agree with the estimates which have been given from time to time, but they now have the authority of actual and disinterested tests. Practically any quality of iron or steel may be produced.

The final conclusions of the committee are worth repetition. Steel of various grades can be produced in the electric furnace economically in competition with the method now in use. Pig iron can be produced, but, under conditions generally prevailing, not economically in competition with our present methods. The difference, however, is not so great but that it may be overbalanced by local conditions. Where a good quality of ore exists in abundant quantities, near an ample water-power supply, and where fuel is dear, the electric furnace will probably be successful. Whether the conditions in Canada are such as to justify a trial of the electric process is not stated in the report.

As regards the future of electric smelting, we quote the following from the report: "When it is considered that the electric process is applicable, also, to the smelting of ores, such as copper, etc., and that the furnaces are of simple construction, the temperature available 1,000 degrees centigrade above that of the blast furnace, and the regulation of the heat supply under perfect control, it is reasonable to expect that the near future will witness great strides in the application of electric energy to the extraction of metal from its ores, and that familiarity with handling large currents and experience gained in electric smelting will result in solving the difficulties encountered in the smelting of ores, which up to the present time have proven refractory to all economical processes known."

A MAGNETOMOTIVE-FORCE METER.

Much ingenuity and a great deal of energy have been expended in investigating the magnetic conditions of dynamo-electric machinery. These methods have usually been based upon electrical measurements, which depended upon the intensity of the magnetic force in and about the machine investigated. From these measurements the total flux at any part of the magnetic path was computed, and from it the fall of magnetic potential along the different portions of the path was estimated. Where it is desired to study relatively the different portions of the magnetic circuit, the old methods are somewhat roundabout, but have been followed for want of a more direct process.

In the *Electrician* (London) for November 25, an ingenious and simple device for measuring magnetomotive forces directly is described by Mr. Rudolf Goldschmidt. The instrument is merely a magnetic shunt. It consists of two L-shaped limbs made up of laminated strips. These are bound together at two ends by non-magnetic braces so as to form an air-gap, within which a sensitive compass needle is placed. The shunt thus has the form of a wide U, and the two free ends are surrounded by magnetizing coils, which complete the instrument. In use it is placed spanning any part of the magnetic circuit along which it is desired to measure the fall of magnetic potential. The magnetic shunt thus formed sets up a magnetic field in the gap in which the compass needle is placed, causing the latter to be deflected. A current from some available source is then passed through the magnetizing coils of the instrument, in a direction so as to oppose the magnetic flux in the shunt. The current is then varied until the needle indicates that a balance has been reached, when the difference of magnetic potential between the poles of the instrument is just equal to the fall of magnetic potential along the circuit spanned. Knowing, then, the current flowing and the number of turns of wire in the two coils, the magnetomotive force is at once given. As the instrument makes use of a zero method, there is no need for close fitting where the poles are placed in contact with the machines under investigation. It is said by the inventor that it gives quite satisfactory results, the error being not more than one or two per cent.

This ingenious instrument should prove very useful to the manufacturer of electrical machinery, as it is available not only for studying new designs, but for testing the machines of standard type, in order to detect any irregularities in the magnetic circuit which would be caused by defective castings, bad joints, etc. The inventor suggests, also, an ingenious application of this device for measuring direct currents without inserting any instrument or shunt in the conductor carrying them. When used for this purpose the instruments are made of a shape so as to surround closely the conductor, forming a magnetic path around it. The same method of obtaining readings is followed, and when a balance is adjusted the current flowing in the coils of the instrument is a measure, within a small error, of the current carried in the conductor.

TELEPHONE ENGINEERING—XIII.

BY J. C. KELSEY.

TELEPHONE SYSTEMS WITH UNCHANGING LINE CONDITIONS.

When a primary coil surrounding an iron core is subjected to an impressed pressure, the current slowly rises to its full strength on account of the retarding effect of self-induction. The induced pressure in the secondary coil is low, on account of the slow rate of change in the strength of the magnetization. But if the circuit is broken, the induced pressure in the secondary winding may rise to many times the value of the impressed pressure, on account of the rapidity in which the magnetization of the core falls to zero value.

The telephone instrument presents this condition. When the receiver is removed from the hook, the current rises to its full strength slowly, and a slow rate of change of induction-core magnetization takes place. A sudden opening of the circuit causes the magnetization of the core to change to zero value instantly. The highest pressure is induced in the secondary winding, and exerts itself upon the receiver in its circuit, which causes the familiar and savage click when the operator answers the call. The three systems, so far studied, deliberately open the line, upon the entrance of the plug, to transfer from line signaling devices to supervisory conditions. The subscriber, therefore, receives two clicks, one vicious from opening and the other mild, upon the restoration of battery pressure.

The Bell and Kellogg systems open both sides of the line, the Stromberg-Carlson one side, and the system shown in Fig. 20 opens neither side. The relay LR is permanently connected across the circuit, and the entrance of the plug makes no change in the electrical conditions of the line, hence the subscriber hears no disagreeable clicks.

This system is of the well-known single-relay type put on the market by the Sterling Electric Company. A twenty-volt battery furnishes energy to the instrument through the balanced 100-ohm windings of relay LR. Not only does this relay take part in signaling of operator, but governs the supervisory signals also. Its windings individualize the circuit, prevent cross-talk, and neutralize extraneous currents. It is a sensitive relay, and gives the system the advantage of having its line and supervisory signals operative through equal resistances.

The single-relay idea is not a new one. It has been worked on, more or less, for several years, without success. The trouble was due to the determination to use line and supervisory lamps of equal voltage.

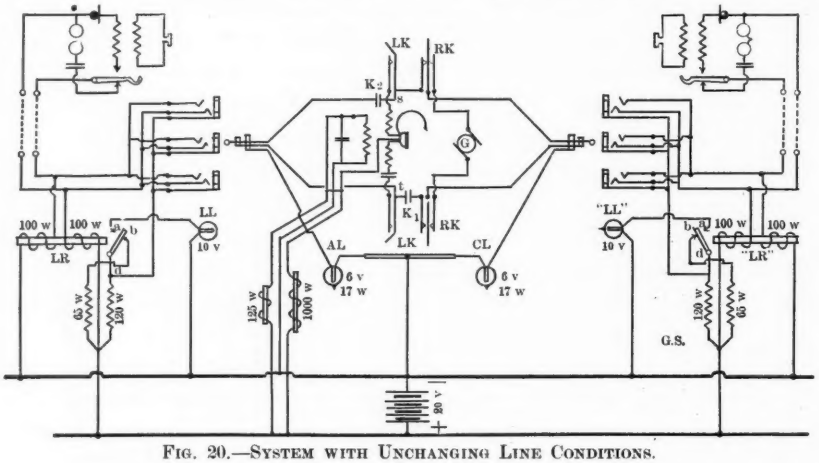


FIG. 20.—SYSTEM WITH UNCHANGING LINE CONDITIONS.

As long as lamps are new, or have equal resistance, the paralleling of line and supervisory lamps would give fair darkening conditions. But lamps are not alike in age and resistance, hence the darkening effect is not positive, and mistakes occur.

Mr. S. B. Fowler made the single-relay system operative by the use of lamps of unequal resistance. When relay LR is energized, contact *a* is closed, and puts a ten-volt lamp of 120-ohm resistance in series with 120 ohms. When the operator plugs in, the six-volt supervisory lamp AL has a circuit through the sleeves, the point *d*, and the same 120-ohm resistance. The lamps LL and AL are in parallel. As lamp AL has a resistance of seventeen ohms, it is plain that it will shunt all the current from LL, and darken it effectually. As the subscriber has the telephone off the hook, the supervisory signal must also show dark, which it does, being in series with 120 ohms. It then receives current from a pressure of two and one-half volts, not enough to redden its filament.

The operator bridges her receiver circuit, and throws LK. The secondary circuit is connected at points *s* and *t*, on opposite sides of condensers K_1 and K_2. The connection *s* at K_2 is necessary on account of the busy test arrangement, for the tip of the calling plug must have actual metallic contact with the busy device. The other terminal is connected at *t*, which prevents the operator from giving the subscribers a click when she breaks into a completed connection. If the touching of the tip gives no response, the operator inserts the calling plug and throws key RK.

If the line is busy, the operator gets the usual clicks. In order to get a test circuit, and preserve the balance of the circuit, the induction coil secondary is split, and the receiver also, and the middle point connected to the positive side of the battery. But the operator receives a very strong test click, owing to the low resistance of the supervisory lamps, which practically raise the potential of sleeves to full twenty volts, and a 1,000-ohm impedance is placed in the test circuit to modify the click.

The insertion of the calling plug into the desired number causes CL to become lighted, as it receives its full voltage, being in series with forty-two ohms. It is placed in series with forty-two ohms by the contact *b* being closed, which puts 120 and sixty-five ohms in parallel.

When the called subscriber answers, line relay LR is energized, and contact *b* broken. Lamp CL will not light when placed in series with 120 ohms. The closing of contact *a* would tend to light lamp LL, but it is effectually shunted by the low resistance of CL.

When the parties hang up, the line relays LR become deenergized, and close the contacts *b*. Lamps LL are removed from circuit, and the sixty-five-ohm resistances are placed in parallel with the 120-ohm resistances. The six-volt lamps thereby light, being in series with forty-two ohms, and the operator pulls down connections.

This system has the advantage of simplicity. It also has the disadvantage of requiring lamps of different voltages. Besides, the low-voltage lamps can not stand the twenty-five per cent overvoltage, due to the daily charge of the battery. The system also has this disadvantage, that it is practically impossible to use line or cord pilot lamps, and night-bell

service, which has a tendency to demand a larger force of night operators.

To overcome these disadvantages, Mr. Fowler put into wide commercial use a two-relay system, which answers all demands, for it uses equal voltage lamps, that of the battery, very little battery current, and gives usage of line and pilot lamps, and night-bell service. For simplicity and excellence, from the operating standpoint, the two-relay system stands alone.

Fig. 21 shows the arrangement in which LR is the permanently bridged relay, with make and break contacts *a* and *b*. COR is the cut-off relay. Unlike other systems, the contacts do not alter line conditions, but simply open and close the line lamp circuit. It is a 500-ohm relay, with back contacts, and is connected between the sleeve of the jack and the positive side of the battery. With LR normal, relay COR is short-circuited by fifteen ohms, and the supervisory lamp will light to full brightness, when sleeves are together. With LR energized, the short-circuit is removed, and the 500-ohm winding cuts down the current of supervisory lamp to one-third value, and darkens it.

The removal of the receiver from hook causes the twenty-four-volt battery to flow through windings of LR, and energize it. Contact *a* closes, and LL and PL light. Contact *b* is opened. The operator plugs in, and the supervisory lamp AL is placed in series with COR, and actuates it. It opens contact *d*, and the line lamp LL goes out. But AL is also darkened, as it receives only eight volts pressure.

The operator tests, plugs in, and rings with RK. The act of plugging in lights CL, as the contact *b* of LR short-circuits COR. When the party answers, relay LR is energized, contact *b* opened, and contact *a* closed. Lamp CL is darkened, and lamp LL kept from lighting by open contact *d*.

There is a single-relay system, used by the Bell licensee systems, in Ohio, Indiana and Illinois particularly. It is a satisfactory system, although open to the objection to being confined to cities of less than 2,000 subscribers. It might be said that the system is a retrogression, as it goes back to the use of a complicated jack, with a pair of series contacts. It uses three strands, does not change line conditions at any time, consumes a small amount of current, and uses lamps of like voltage.

According to Fig. 22, the line relay is permanently bridged across the line, and battery of thirty-six volts pressure is furnished the instruments through the 500-ohm windings of LR. There is also wound on the relay LR a non-inductive winding of 120 ohms resistance. This 120-ohm winding acts in series with the twenty-four-volt line and supervisory lamps, and for economy in space and simplicity has been wound on the relay.

When the receiver is removed, LR is energized, making contact *a* and breaking contact *b*. When contact *a* is made, the battery current flows through 120-ohm resistance on LR, through line lamp LL., the series contacts *e*, *f* and *g* of the succeeding line jacks, and thence to ground. Seeing the lighted lamp, the operator inserts the plug, let us say, into the jack with contact *e*. The line circuit is mechanically broken at *e*, and the line lamp disassociated from the connection. The entrance of the plug brings the jack and plug sleeves together, but lamp AL can not light, as the circuit is broken at *b*.

Should the subscriber become impatient, the raising and lowering of the hook would alternate contact *b*, and would cause AL to wink. The operator, having answered the call by key LK, tests, and if not busy rings on line with RK. The insertion of the plug lights CL, as contact *b* is closed. When party answers, LR is actuated, *b* contact broken, and CL is darkened.

The busy test is a distinctive feature. Normally, the touching of the tip to the sleeve of the jack does not indicate anything, as both tip and tested sleeve are at same negative potential. The entrance of a plug elsewhere changes the potential of the sleeves to positive potential. When the tip is touched to the positive potential, the current flows from the jack sleeve through the plug tip, and thence to negative battery through the inductive winding of T. Energy is stored up in T, which, when the tip is withdrawn, dissipates itself in a closed circuit consisting of the secondary circuit of the induction coil, the receiver, winding T', the battery, and thence to T, the source, and resulting in a moderate though decided click.

When the subscribers hang up receivers, relays LR become normal, close contacts *b*, and the supervisory lamps AL and CL get their proper voltage. Receiving a double disconnect signal, the operator pulls down the connnection. There remains one chance to disturb line condi-

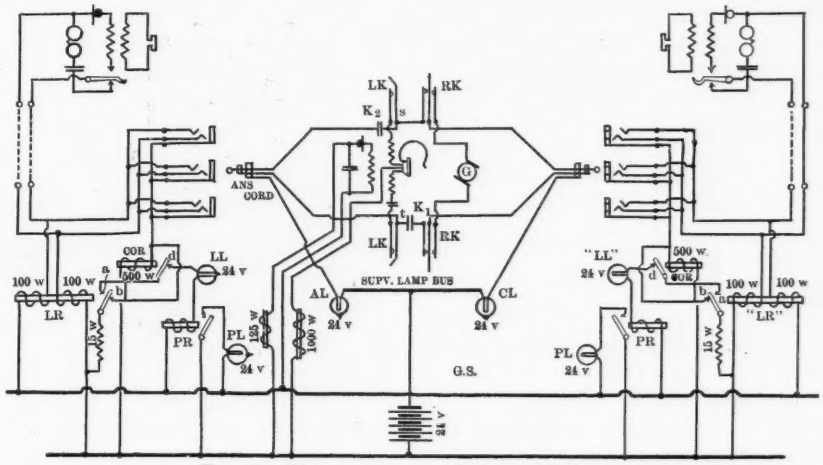


FIG. 21.—MODIFICATION OF PREVIOUS DIAGRAM.

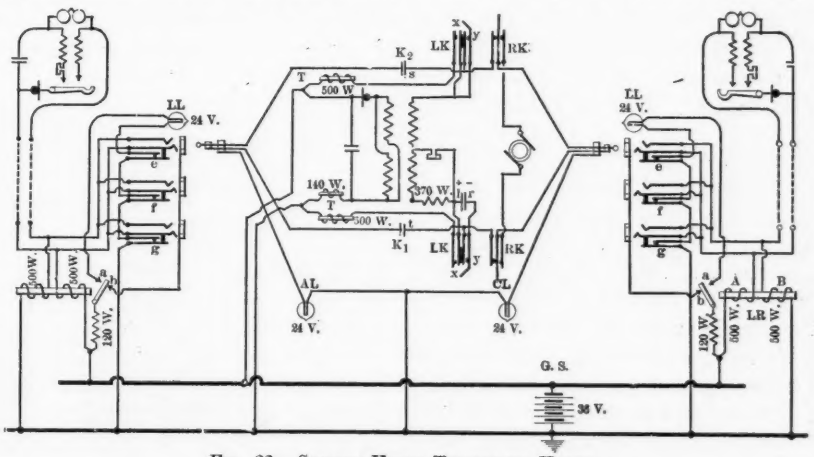


FIG. 22.—SYSTEM USING THIRTY-SIX VOLTS.

tions, through the operator's telephone set. The commercial condenser K will not retain its charge, and when the secondary circuit is bridged across the line, the line potential is lowered by reason of the condenser K absorbing some energy. To prevent this absorption, the key LK has its springs so arranged that contacts x close in advance of y. When x closes, the condenser plate l is given a positive charge through coil T', which induces a bound negative charge on plate r. When the plug is fully inserted, plate r would be subjected to a negative potential, but owing to prior closing of x that condition has been attained, and no energy can be absorbed from the line connections.

This system is known as the No. 8, and is extensively used by the Central Union Telephone Company, which serves more cities of moderate size than any other telephone institution in the world.

Dinner of the Carnegie Veterans' Association.

On Friday evening, December 2, Mr. Andrew Carnegie gave a dinner to the members of the Carnegie Veterans' Association, his lieutenants when he was the active head of the Carnegie Steel Company, and his closest friends. The dinner was given in Mr. Carnegie's residence in New York city, Fifth avenue and Ninety-first street. Including the host, there were forty-four steel men of international reputation at the dinner. This was the third annual dinner of the association, and in many respects was the most interesting of any that have been held. Among those present were Mr. Charles M. Schwab, W. E. Corey, president of the United States Steel Corporation; A. C. Dinkey, president of the Carnegie Steel Company; Lawrence C. Phipps, George Lauder and W. C. McCausland.

At the formal meeting of the association Mr. Carnegie was nominated by Mr. Schwab to succeed himself as president, and the nomination was made unanimous. Mr. Carnegie nominated Mr. Schwab for the vice-presidency, and this was also made unanimous. Charles L. Taylor was reelected as secretary and treasurer.

After the banquet Mr. Carnegie toasted his guests, and in the speaking he was followed by Mr. Schwab and H. P. Bope, vice-president of the Carnegie Steel Company. Others who spoke were Thomas Lynch, president of the Frick Coal Company; W. E. Corey, J. H. Reed, chairman of the Carnegie Steel Company; John J. Leischman, James Gayley, W. B. Dixon, A. C. Dinkey, George Lauder and W. H. Swift.

The Unipolar Dynamo.[1]

The old problem of the commercial application of unipolar dynamos is discussed in some detail by J. Seidener in a recent number of the *Zeitschrift für Elektrotechnik,* more especially with reference to their combination with steam turbines.

The writer points out that the great advantage of these machines is the sparklessness of the current collection, owing to the absence of a commutator, while at

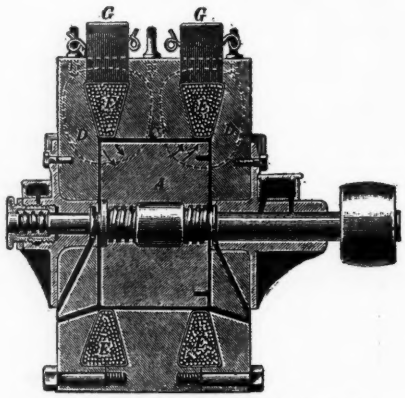
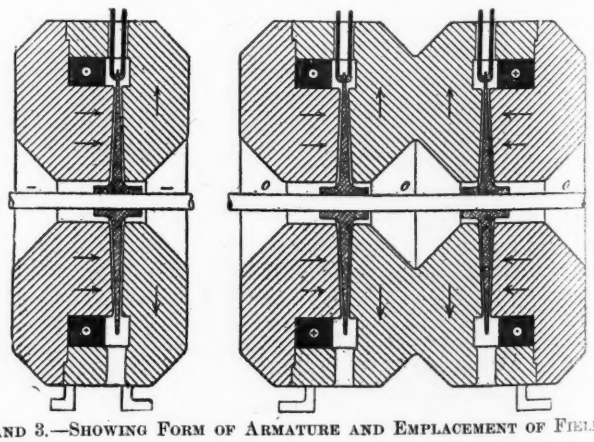


FIG. 1.—FORBES UNIPOLAR DYNAMO.

the same time one of the chief difficulties experienced with them in practice is connected with this very point of current collection. The high peripheral speeds demanded for the production of ordinary working voltages without an excessive expenditure of material involve a high friction loss at the collecting brushes, especially if the revolving surface is at all out of true, as that, naturally, necessitates a high brush pressure in order to prevent vibration.

On this account the well-known Forbes unipolar machine (Fig. 1), with a solid cylindrical armature and the current collected at the two ends of the cylindrical surface, is especially difficult to deal with, as the exact balancing of a massive cylinder is almost impossible.

When the armature, however, takes the form of a thin disc (Fig. 2) this difficulty is much more readily overcome, chiefly because a thin disc can be more easily obtained of homogeneous quality throughout than a solid cylinder. Comparing Fig. 2 with Fig. 1, a little consideration will show that for the same number of revolutions per minute and the same external diameter of rotating part, the disc machine will only develop half the electromotive force of the cylinder machine, though at the same time the weight of material in the disc machine is only half that in the cylinder machine. In order to obtain the same electromotive force in both cases, it would be necessary to employ two disc machines in series. Now, in the cylinder machine current collection takes place at two points, both at the maximum peripheral speed. Two disc machines would, together, require four collecting points, of which two would be at the maximum peripheral speed, and two at the minimum peripheral speed, *i. e.*, on the spindle. The two latter collecting points may, however, be eliminated if the two spindles are electrically connected together, and the direction of excitation of the two field coils is arranged so that the two voltages act in series through the spindle. In this case (shown in Fig. 3) the disc machine has only two collecting points at the maximum peripheral speed, just as in the case of the cylinder machine, and the complete weight of material in the two types is the same. Such a two-disc machine is, incidentally, capable of acting as a three-wire dynamo if the middle wire is connected to the spindle. Each side can have its voltage independently regulated by means of the exciting coil on that side.



FIGS. 2 AND 3.—SHOWING FORM OF ARMATURE AND EMPLACEMENT OF FIELD COILS.

It may be pointed out that the dimensions of a unipolar machine depend far more on the voltage required than on the current. The section of material between

[1] *Electrical Review*, London, November 18.

the points of maximum and minimum potential in the rotating part is, from mechanical and magnetic considerations, already so large that it makes little difference whether the machine is intended to give ten amperes or 1,000 amperes. It is clear, on this account, that these machines can not advantageously be built for small outputs, and are especially suitable for comparatively small voltages and large currents.

Armature reaction, in the ordinary sense of the term, is practically absent, partly because of the low value of the amperes per unit length of armature periphery, and partly because, from the arrangement of the machine, actual armature reaction of the sort that exists in ordinary machines can not occur.

The collection of the currents, both in the cylinder and in the disc type of machine, is greatly improved if, in place of using the cylindrical outer periphery as the collecting surface, part of the circular end surface is used for this purpose.

Though there is great difficulty in obtaining a truly cylindrical surface (even if the final trueing up is carried out at the actual working speed), yet the side faces of a disc made of homogeneous elastic material will approximate more and more to a perfectly flat surface, the higher the speed at which the disc is rotated. With regard to strength the disc of a unipolar machine is even better off than a De Laval turbine wheel, as the former, when sideway current collection is employed, need not even be thickened at the outer periphery, and so has no additional weight to carry there.

In the case of small moderate speed machines, the discs would usually be made of material of high electrical conductivity, but bad magnetic quality, such as hard copper, bronze, etc. For large machines and high-speed machines generally, the thickness of the disc near the spindle necessitated by mechanical considerations would be so great that the air-gap at the inner portions of the disc would become excessive, and make these inner portions almost valueless as far as the production of electromotive force was concerned. If, however, steel or iron is employed as the disc material, the only air-gap in the path of the flux is the sum of the clearances on the two sides of the disc, and this leads to a great saving in the weight of exciting winding required, as compared with the non-magnetic disc type. Since all parts of the disc are at all times in a field of the same density, no hysteresis loss can occur.

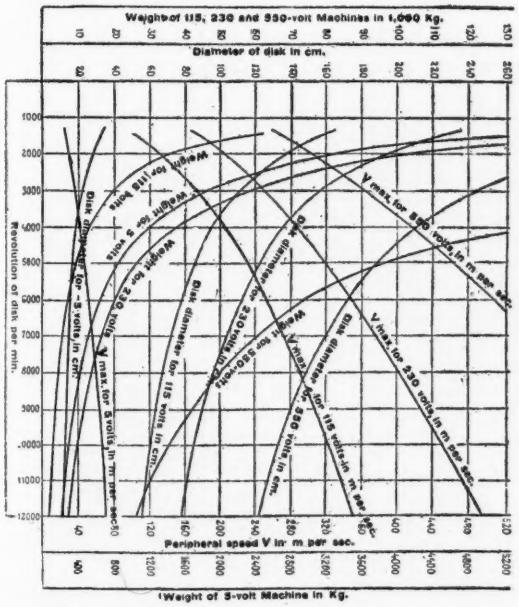

Weight of 115, 230 and 550-volt Machines in 1,000 Kg.
Diameter of disk in cm.
Revolutions of disk per min.
Peripheral speed V in m per sec.
Weight of 3-volt Machine in Kg.
Weight for 115 Volts
Weight for 5 volts
Weight for 230 Volts
Weight for 550 Volts
Disk diameter for 3 volts in cm.
V max. for 3 volts in m per sec.
Disk diameter for 115 volts in cm.
Disk diameter for 230 volts in cm.
Disk diameter for 550 volts in cm.
V max. for 115 volts in m per sec.
V max. for 230 volts in m per sec.
V max. for 550 volts in m per sec.

FIG. 4.—CALCULATIONS FOR DIFFERENT FORMS OF MACHINES.

There is, however, some danger of a one-sided magnetic drag on the disc, owing to the fact that some magnetic leakage occurs at the outer periphery of the disc, giving a higher flux density on one side of the disc than on the other. This difficulty can be avoided by replacing each of the exciting coils shown in Fig. 3 by two equal coils, placed one on each side of each disc, thus making the arrangement about each disc symmetrical and preventing all peripheral leakage.

The employment of discs of magnetic material and the avoidance of all thickening of the disc at the outer periphery for collecting purposes (by collecting the current from the side faces) enables extremely high speeds to be utilized, and the writer is of opinion that the introduction of machines of this double disc unipolar type is likely to receive a considerable impetus in connection with the manufacture of steam turbines, both on account of the high speeds involved, and also because the manufacture of steam turbines has led to increased experience in the construction of high-speed machine parts. In any case, in view of the difficulties met with when constructing ordinary direct-current dynamos for coupling to steam turbines, both as regards commutation and the high centrifugal forces involved, a reconstruction of such unipolar machines would seem to be justified.

In order to show the sort of dimensions necessitated with this type of machine, the results of a series of calculations on machines for five volts (plating dynamos), 115 and 230 volts (lighting dynamos), and 550 volts (traction dynamos), are shown in Fig. 4. The magnets were in all cases assumed to be of cast steel, the flux density in the air and in the steel was taken as B = 15,000 centimetre-gramme-second lines per square centimetre, the voltage drop in the disc was neglected, the projecting part of the disc used for current collection was taken as 0.05 D where D = outer diameter of disc in centimetres, the air-gap was assumed to increase directly with the diameter of the disc, so that the section of the exciting coils also increased proportionately to the diameter. The inner diameter of the disc was taken as 0.15 D, so that the active radial length of the pole-face $= l = 0.375$ D, and the average peripheral speed in metres per second

$$= v = \frac{\pi \times 0.525 \text{ D} \times n}{60}, \text{ where } n =$$

number of revolutions per minute.

The electromotive force induced in the two discs together is—

$$\text{E} = \frac{2 . l . v . \text{B}}{10^8} =$$

$$\frac{2 \times 0.375 \text{ D} \times \pi \times 0.525 \text{ D} \times n \times 15{,}000}{60 \times 10^8}$$

$$= 3.08 \text{ D}^2 . n . 10^{-6},$$

or

$$\text{D} = 570 \sqrt{\frac{\text{E}}{n}} \text{ in centimetres.}$$

The weights shown on the curve were obtained by proportion from a single complete working, assuming that the weight varied as the cube of the diameter of the disc—the expression being : weight in kilogrammes $= 0.0146 \times \text{D}^3$.

Machines of this type show a decidedly lower proportion of labor to cost of material than in the case of ordinary machines, principally because their massive build necessitates very little machining. The ratio of copper weight to steel weight is also very low. With a five-millimetre air-gap on each side of the disc, and a disc about 100 centimetres in diameter, this ratio worked out at only three to three and one-half per cent.

The La Goule Hydroelectric Plant at Noirmont, Switzerland.

By Franz Koester.

ONE of the most interesting power plants in the mountain range of the Berner Jura, Switzerland, for distributing electric currents over a number of towns, is that of La Goule. Water is taken from the river Doubs, which for a long distance below Les Brenets forms the boundary between France and Switzerland. This river has cut its way through the mountains, and flows in rapids to a point called La Goule, where in the fourteenth century the whole river was dammed by a landslide from the mountain on the French side. This natural dam forms a lake with a head of about seventy-six feet.

Among the inhabitants of the surrounding country there have been established many small industries, especially that of watchmaking. Before the introduction of electric transmission, this work was done mostly by hand power, or petroleum motors were made use of.

The Oerlikon Machine Company, who designed this plant, proposed the single-phase, high-tension, alternating current for the distribution of this power. The towns served by this current are so widely scattered, in about sixteen miles radius, that it was deemed better to use alternating current than direct current. Where direct current is required, it is cheaper to install rotary transformers than to use primary direct-current lines.

Two independent distribution lines were constructed, one for the power circuit and one for lights. This produces a more steady current for the lights, but, of course, requires double-transformer stations. Notwithstanding the greater first cost of this system, it is far preferable.

Generators are interchangeable, so that in case of failure of the lighting generators, the power generators may be used, and *vice versa*. One turbine generator set is held in reserve, so that it is hardly possible to have lack of current on all lines.

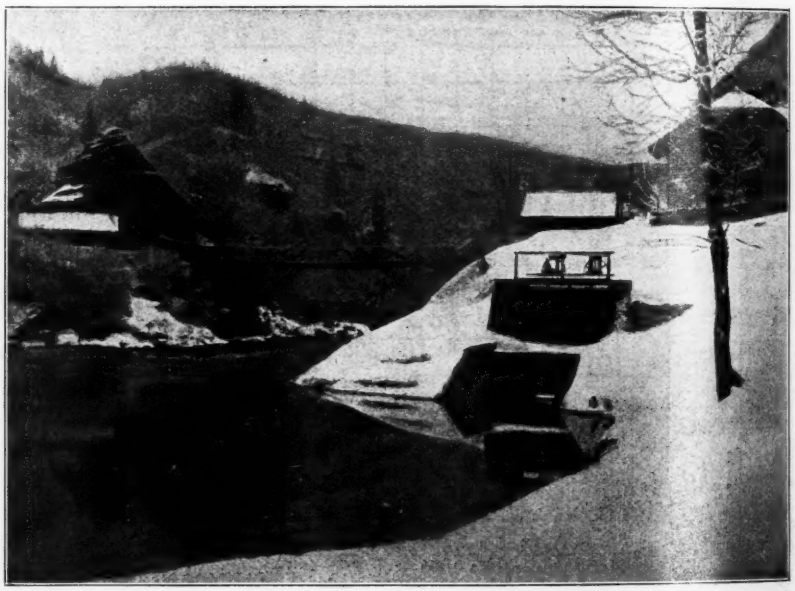
Messrs. Escher, Wyss & Co., of Zürich, built the penstock and turbines, while the water conduits and the buildings were constructed by Rotacher & Co., of St. Imier. The entire electric equipment, including the distribution system was constructed and installed by the Maschinenfobric Oerlikon, of Oerlikon, Switzerland.

At ordinary low water there flows about 235 cubic feet per second, which corresponds to 2,000 horse-power, which is the capacity of the first installation of machinery. But the dam and conduits are built for 4,000 horse-power or 565 to 615 cubic feet per second. The power plant may be easily enlarged to this capacity.

The net head under which the plant operates is seventy-nine feet. The total length of the water conduit is 520 metres (1,705 feet), of which 440 metres (1,443 feet) is a tunnel through the mountain, while the remainder is cut from the mountain slope partly with one wall of concrete and partly with two walls. About eighty metres (265 feet) from the entrance to the tunnel there is a sluice, and a sand and gravel trap. Further along are two overflow gates. On account of the enormous variations in the head, it was necessary to build the first fifty metres (164 feet) of the tunnel and the inlet gate extra strong. The grade of the tunnel is one per cent. A bulkhead is built at the outlet of the tunnel, in which is inserted the steel penstock 2.25 metres (7.38 feet) in diameter built of sections, six metres (19.6 feet long). In developing 2,000 horse-power the velocity of the water in the tunnel is 1.98 to 2.30 metres (6.55 to 7.5 feet) and in the penstock 2.14 metres (6.91 feet). The penstock leads down the mountain slope and enters the basement of the power-house through the end wall, near one side, delivering water to the turbines through branches 1,200 millimetres (forty-seven inches) diameter.

The power-house is built with two floors, the basement being occupied on one side by the penstock, and on the other by the turbines, which are of the vertical type. The second floor is occupied by the electric generators, direct connected to the turbines. By this arrangement the turbines are in an entirely separate room from the electric generators.

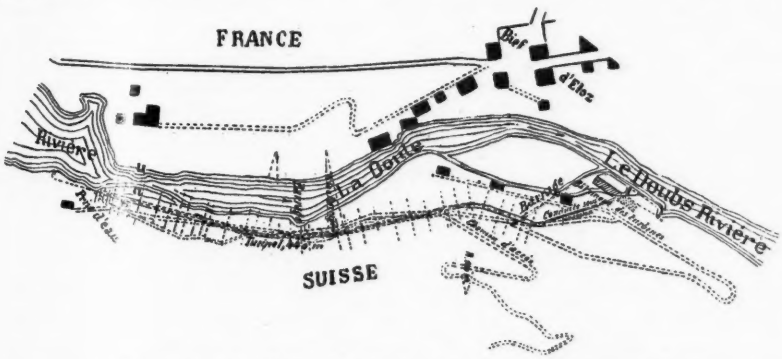
The house is built to contain four generator units, and their four exciters. The dimensions of the power-house are 21.2 metres (69 feet) long and 8 metres (26.2 feet) wide. For erecting and handling the machinery the plant is equipped with a ten-ton hand crane. One end of the building is devoted to a machine shop, which is 5 metres (16.4 feet) by 8 metres (26.2 feet). Above the machine shop is an office. A small independent hydroelectric unit in the machine shop furnishes light for the power-house, shop, office and yard, by means of arc and incandescent lamps.



Head Gates, La Goule Hydroelectric Plant, Noirmont, Switzerland.

There are two different types of turbines, the Francis-Comè, Escher, Wyss & Company system, and the straight Francis with movable buckets. The first installation consists of three turbines of 500 horse-power each, making 200 revolutions per minute. The next installation was one turbine of 650 horse-power, making 375 revolutions per minute. The 500 horse-power turbine has a hollow cast-iron shaft, inside of which is a wrought-iron

stationary shaft partly to carry the weight of the electric generator, and partly to centre the turbine shaft. The principal weight of the generator is carried by a piston and hydraulic pressure.



Topography of Vicinity at La Goule Hydroelectric Plant, Noirmont, Switzerland.

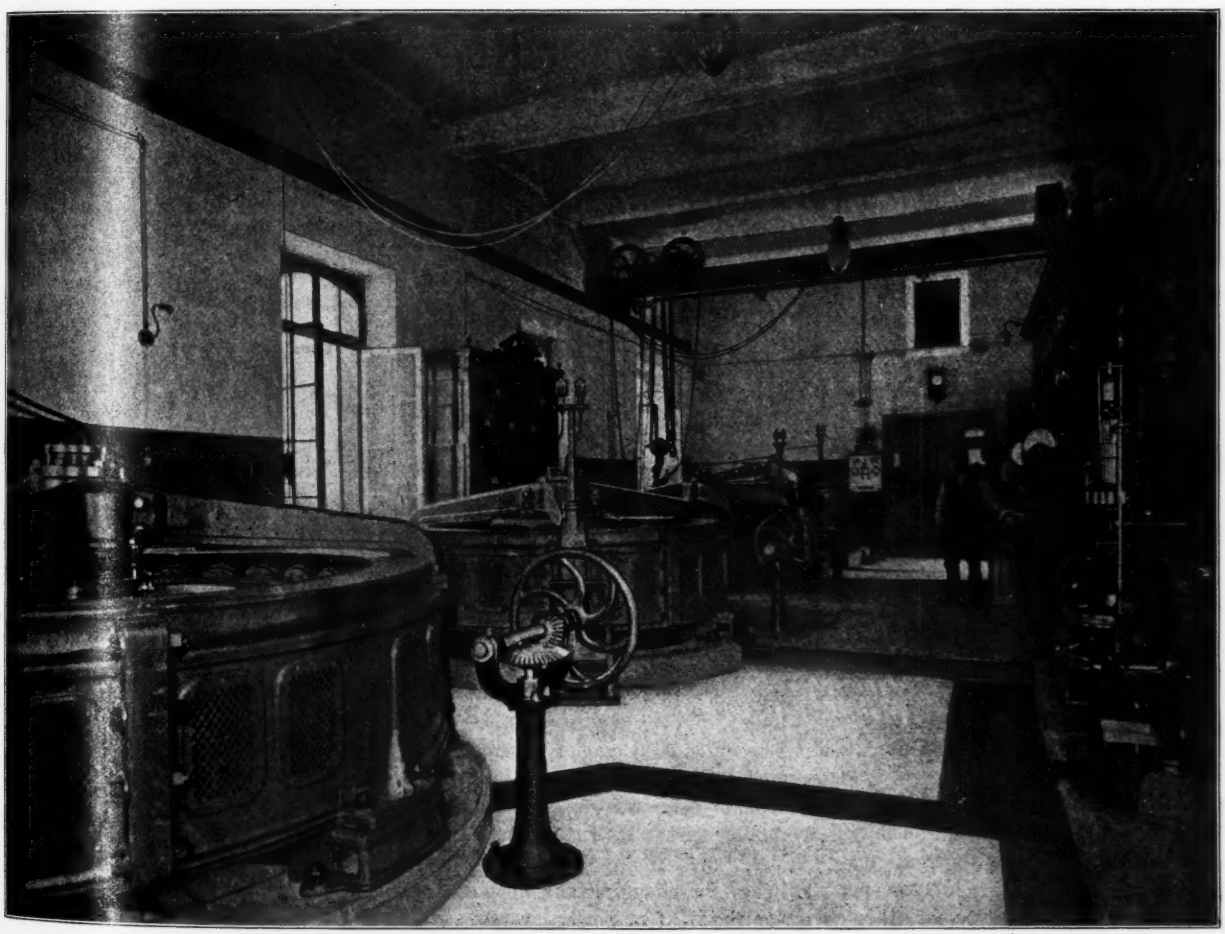
On account of variations in the level of the tail water, the turbines are provided with draft tubes, through which the exhaust water is discharged. Each turbine shaft is provided with a pair of bevel gears to run a horizontal shaft, which drives an exciter generator. The speed governor is entirely mechanical, and is of the ratchet and pawl type, as patented by Escher, Wyss & Company. On testing this turbine, it developed an average of 560 horse-power under a head of 24.9 metres (81.6 feet), showing a net efficiency of eighty per cent with three-quarters load and seventy-nine per cent with full load.

The 650 horse-power turbine is also of the vertical type. It has a solid steel shaft, with no foot-step. It is supported by collars above the housing, and the weight is equalized by a hydraulic piston. This turbine is governed by a hydraulic regulator, consisting of a cylinder in which a piston is moved by water pressure from the penstock. A test of this turbine under a head of 24.59 metres (80.6 feet) gave a horse-power of 730, with 375 revolutions, and a net efficiency of eighty-one per cent at three-quarters gate and seventy-nine per cent at full gate and seventy-five per cent at half gate.

The supplementary turbine operating the shop runs 620 revolutions and develops 5.6 horse-power. It is a spoon type, Escher-Wyss system, and has only one inlet. It has a governor of the same style as the 650 horse-power turbine.

Three 500 horse-power alternating-current electric generators, Oerlikon type, are direct connected to the vertical shafts of the turbines, so that the rotary fields make 200 revolutions per minute. While developing 500 horse-power they generate current of seventy-three amperes and 5,500 volts, fifty cycles per second, with an efficiency of ninety-four per cent.

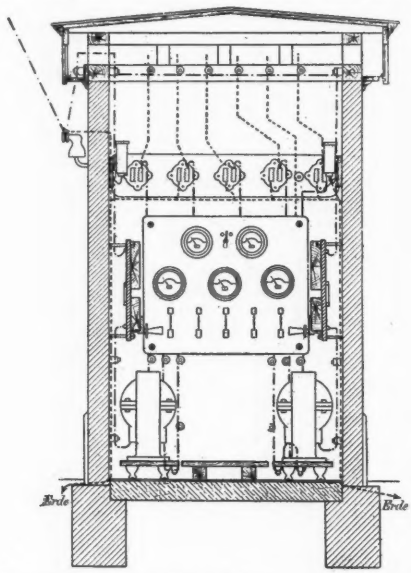
The winding of the armature consists



Interior of Central Station, La Goule Hydroelectric Plant, Noirmont, Switzerland.

of thirty double coils, which are pressed into the slots. Each coil has twenty turns of wire with a cross section 4.1 by 4.7 millimetres. The field has thirty poles, containing, altogether 500 turns of wire 5.5 by 6.2 millimetres. The rotary field weighs 9,800 kilogrammes. The diameter is 2,488 millimetres (98 inches). Two spiders, one at the top and one at the bottom of the stationary armature carry two bearings for the shaft of the revolving field.

The fourth generator of 650 horse-power runs at 375 revolutions per minute and has an output of 100 amperes, 5,500 volts, and fifty cycles per second, with a net efficiency of 94.8 per cent. The armature has sixty-four slots and thirty-two coils. Each coil has eleven conductors, three wires each, 3.8 by 4.4 millimetres. The field has sixteen coils wound in series. Each coil has eighteen turns of sheet copper 180 by 1.5 millimetres. These are insulated from one another by sheets of asbestos. The weight of the magnetic



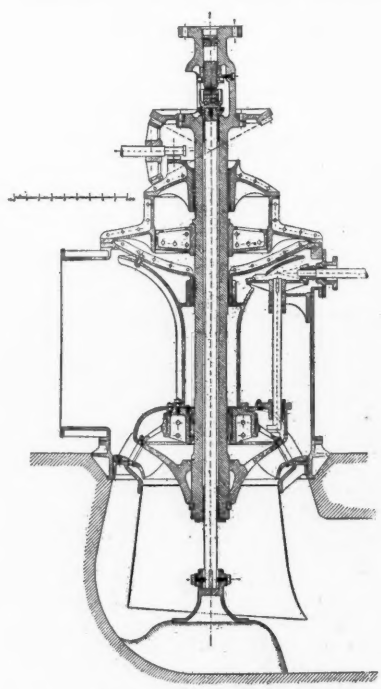
LAYOUT OF TRANSFORMER STATION, LA GOULE HYDROELECTRIC PLANT, NOIRMONT, SWITZERLAND.

field is 9,400 kilogrammes, and diameter 1,792 millimetres (70.5 inches).

The efficiency of the exciter used for the 500 horse-power generator is seventy-five per cent and that of the 650 horse-power generator seventy-eight per cent. The exciters are bi-polar, direct-current machines, running 700 revolutions per minute, and with capacity of thirty amperes and eighty volts.

The dynamo in the machine shop is driven by a small independent turbine, and is of the Oerlikon type. It runs at 1,300 revolutions per minute, developing four horse-power, twenty amperes and 125 volts. The iron revolving armature is 180 millimetres (seven inches) in diameter and 160 millimetres (6.75 inches) long, and has fifty spools, each containing eight wires 1.6 by 2.2 millimetres. The internal diameter of the magnet field is 187 millimetres (7.5 inches) and consists of two spools, each with 3,024 turns of wire 1.2 by 1.6 millimetres.

Wires are run from the generators in underground conduits to the two switchboards which are arranged one on each side wall of the power-house. The main

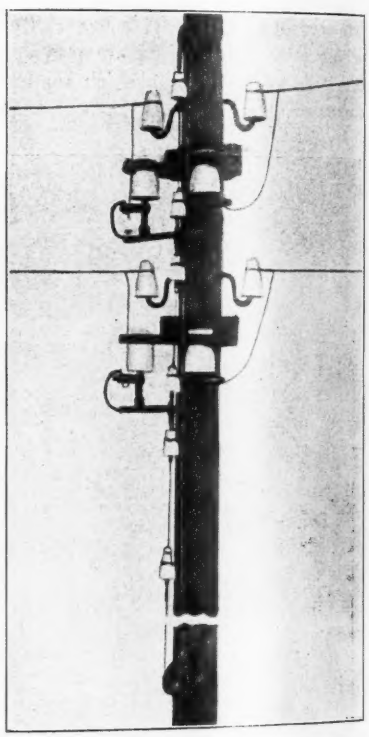


CROSS-SECTION OF TURBINE, LA GOULE HYDROELECTRIC PLANT, NOIRMONT, SWITZERLAND.

switchboard is for the Swiss main lines, the smaller board is for the French circuits. Each board is, of course, equipped with the necessary switches and measuring instruments, which are mounted on black marble panels. Light and power circuits are kept entirely distinct, the light circuits being on the left panel, the power circuits on the right, and the main switches from the generators in the centre panel, which also carries the voltmeters, ammeters, hand regulators for the exciters, the phase indicators for use in parallel switching of the alternating-current machines, and finally the double-throw switches for changing any machine into either the light or power circuits. Each of the outside panels carries double-pole fuse blocks and two lightning arresters, also voltmeters which are connected through transformers to show the fluctuation of the current at the furthest point of the territory served. There is, also, an optical signal system on the switchboards.

A similar system of instruments is on the marble switchboard for the French circuits, arranged to separate the power from the light circuits. Behind the main switchboard is a transformer held in reserve to transform the 5,500-volt current down to 120 volts for lighting the power-house, in case the supplementary lighting dynamo should fail.

On account of the unusually severe winters, and the long time that snow lies on the ground, often as deep as two metres, it was found necessary to build an unusually strong pole line. The poles are set up in the form of an inverted V, bolted together at the top, and extend 1.5 metres (5.9 feet) in the ground. The poles are fourteen to eighteen centi-



CUTOUT SWITCH IN LINE, LA GOULE HYDROELECTRIC PLANT, NOIRMONT, SWITZERLAND.

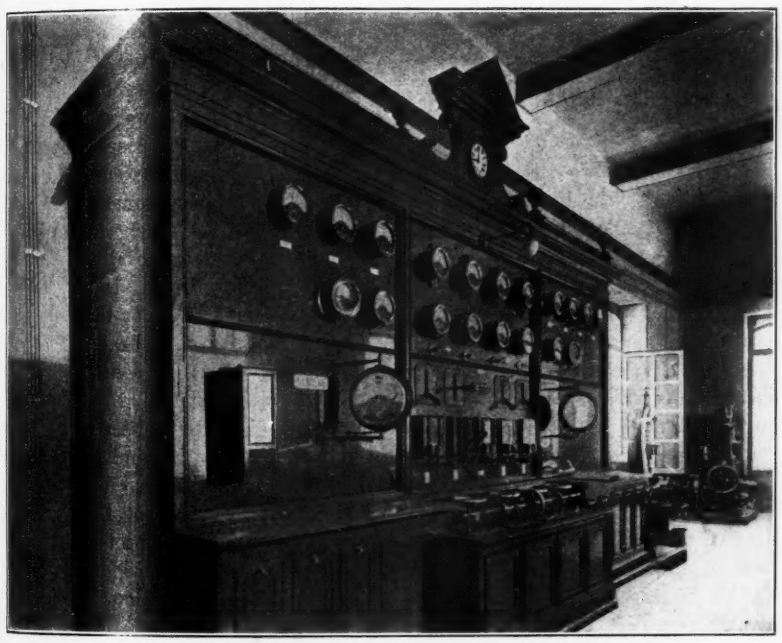
metres (5.5 by 7 inches) in diameter and ten to twelve metres long (32.8 to 38.4 feet). The average distance between the poles is about forty-five metres (150 feet). The sag of the main lines is fixed at two per cent, instead of one and one-half per cent, the customary amount in Switzerland. This allows more expansion and contraction. Special care is used in making the joints in the line wire. All wires above six millimetres (0.2362 inch) diameter are soldered in sleeves. Ordinary bell-shaped porcelain insulators are used. All main branch lines are provided with switches on the poles which may be operated from

the ground. These switches allow certain sections of the line to be cut out for repairs or inspection without interruption of the service. At railroad crossings cable lines are carried underground through conduits lined with marble or porcelain.

Three power circuits and three light circuits serve the Swiss territory, while two power and light circuits serve the French territory. The main lines in Switzerland are about 44.7 kilometres (twenty-eight miles) long and in France about 44.3 (27.8 miles). The total length of line wire used in Switzerland is 285.6 kilometres (178.5 miles) and in France 188.5 kilometres (118 miles). Brick transformer houses are built in each town, of varying sizes, to contain from one to five transformers in Switzerland (five being in St. Imier), and from one to four in France (four being in Maiche). The transformers vary in capacity from four to seventy-five kilowatts. In most cases there are in the same station at least two transformers; one for light, and one for power. All transformer stations have a white marble switchboard, equipped with instruments, switches and lightning arresters for both the high-tension and the secondary circuits.

There are two separate secondary circuits from the transformer stations, run as the three-wire system on poles. On the power circuits the special motors (built by the Oerlikon Company) regularly work from the outside wires, the neutral wire being only used for starting, as will be hereafter explained. Each motor (single-phase alternating) is provided with a tight and loose pulley, so that the motor may be started empty. On the switchboard there is a double-throw switch, which thrown one way connects half the voltage (from one side to neutral wire) to the motor. At the same time an iron core is inserted in an induction coil by means of a hand-wheel. When the motor reaches full speed the switches may be quickly thrown over to connect the full voltage from the outside wires, and then the load may be thrown on the motor.

In Switzerland there are a large number of very small motors, some of them as small as one-tenth horse-power for watchmakers. St. Imier has the largest size, 120 horse-power which is a rotary transformer for the city. In France the motors range from one-tenth horse-power to forty horse-power.



MAIN SWITCHBOARD, GENERATING PLANT, LA GOULE HYDROELECTRIC PLANT, NOIRMONT, SWITZERLAND.

In both France and Switzerland the total number of customers served is 889. There are more than 8,000 lamps in the system.

Charges for the currents are as follows: Lights for private houses 1.40 francs per candle-power per year (about $4.25) for sixteen candle-power. Municipal lighting is at the same rate, based on thirty-five francs per twenty-five candle-power per year. A special rate is made to manufacturers of one franc per candle-power per year. Power in one motor one-quarter horse-power 134 francs per year; one horse-power 430 francs; two to twelve horse-power 325 francs. Above twelve horse-power a special arrangement is made.

The plant is in continuous operation, except for a stop of half an hour at noon.

The Madison Branch of the American Institute of Electrical Engineers.

Two regular monthly meetings of this branch have been held, in addition to six student meetings, which student meetings are carried on as a part of the regular work of certain senior and graduate students in engineering at the University of Wisconsin. The first monthly meeting was held October 26th. The election of officers for the year was held at this time and resulted in the selection of Mr. J. P. Mallett, chief engineer of the Northern Electric Manufacturing Company, as chairman, G. C. Shaad as secretary, and F. W. Huels as a third member of the executive committee. The papers presented at the New York meeting in September were abstracted by Messrs. Potter and Jorstad.

The second monthly meeting was held December 1st. At this meeting the paper on the telautograph was abstracted by Mr. R. F. Robinson, and the paper on the transposition of electrical conductors was presented by Mr. R. C. Muir. Mr. J. C. Potter prepared an opening to the general discussion in each case.

At the student meetings several papers, based mainly on previous papers presented in the Institute and covering a variety of subjects, have been presented and discussed. There are at present ten students electing this work, the number of students who are allowed to elect this course being limited.

For a Municipal Lighting Plant in New York City.

The board of estimate of the city of New York has adopted a resolution directing the corporation counsel to prepare a bill, to be presented at the next session of the legislature, so amending the charter as to permit the city to build an electric plant for the lighting of streets, parks and public buildings. The resolution provides that the bill be sent to Albany as a city bill, endorsed by the municipal government. It is expected that by making the measure a city bill it will have a fair prospect of passing in the legislature. It is unlikely that the city will build a plant, even should the bill go through.

World's Water Power.

Mr. George Johnson, statistician, of the Dominion of Canada, says the amount of water power used for electrical production throughout the world at present is over 2,000,000 horse-power. Canada has over one-tenth of the whole. The United States figures are 527,467 and Canada's 228,225.

Commercial Aspects of Telephone Line Protection.

By Kempster B. Miller.

THE problems involved in telephone line and apparatus protection are numerous and varied because of the widely different conditions which may, and often do arise to make protection necessary. To-day the protective apparatus used in a telephone plant forms an important part of the entire equipment, as on it depends not only the safety of the lives of the operators and users, but of the physical property of the telephone company and that of its customers.

The presence of the street railway and electric lighting and other systems in the allied fields of electrical engineering, and the advent of the common battery system now largely used in the telephone industry itself, has placed before the telephone engineer more and more complex conditions.

There are broadly three elements against which apparatus must be protected: lightning, high-tension currents, such as may be caused to flow on a telephone line by a cross with electric light or power wires; and sneak currents, which are currents too small to do instantaneous damage, but which, if they persist, may, by the accumulation of heat, cause damage to the apparatus. Unless danger from consequent fire be taken into account, only the first two causes need be considered in regard to the danger to human life.

The types of apparatus for protecting against one or all of these sources of danger are well known. It is the purpose of this article to consider where and under what conditions protection should be given, and under what conditions it is better to take some risk and give only partial protection or none at all.

Carbon-block arresters, wherein two carbon blocks separated by a thin air-gap are used as a "safety valve" for high potentials, are now almost universally employed for protection against lightning, and against all currents such as might produce potentials of, say, 350 volts or over between the line and ground. With a distance of .005 of an inch between the carbon blocks a pressure of 350 volts across the blocks will break down the insulation of the air-gap between them.

This kind of an arrester, of course, operates by grounding the line either temporarily or permanently; and in the case of a lightning discharge, which persists for only a minute period of time, no other protection is necessary. However, a high potential current due to a cross with a high tension wire is likely to persist after being grounded, and thus cause a very large current to flow over the conductor so grounded, which may be injurious to the line wire or cable itself. For this reason it becomes desirable to provide some means for opening the circuit after it has been grounded in case the current allowed to flow on account of the grounding is of sufficient magnitude to become dangerous. The most simple means of accomplishing this consists of a fuse wire of limited carrying capacity.

Sneak currents may be caused by low potential crosses somewhere on the line, or of comparatively high potential crosses through a high resistance. In common battery work still another very common cause of sneak currents is due to the grounding of one of the telephone wires or the crossing of two wires, in which cases, even though the lines are not subjected to any outside electromotive force, the current flowing from the common battery may, in some systems, persist to such an extent as to cause ultimate damage to the apparatus.

The most simple means of protection against these small currents is to employ a fuse wire of very small carrying capacity, mounted on mica strips to which they are secured. These are not very efficient forms of sneak-current arresters, for the reason that they can not be depended upon to open the circuit when traversed by current of predetermined strength. Another disadvantage is that, on account of their small size, they are very frail and liable to mechanical injury. The well-known heat coil is the most effective sneak-current arrester yet put into extensive use.

For protection against heavy currents such as may be caused to flow in the line after the heat coil has operated and grounded the line conductor, comparatively heavy fuses—five to ten amperes—usually mounted in wooden or fibre tubes are found most desirable. These are not so much subject to the frailties of mechanical construction as the mica fuses, and may, therefore, be used on outside construction with considerable freedom.

By the judicious use of all of these general types of protectors, a degree of protection that is well-nigh absolute, may be attained; but there is a difference of opinion as to whether or not absolute protection is at all desirable. Under conditions made necessary for absolute protection the heat coils, on account of their extreme sensitiveness, may be frequently operated by the normal currents of the exchange; again, if the line fuses are made of too low carrying capacity very slight currents which might injure nothing would also cause their operation. If the gaps in the carbon arresters are made too small, the liability of short-circuiting the line to ground by the accidental contact between the carbons, or the presence of a small amount of carbon dust, would exist.

The blowing of a heat coil or the short-circuiting of the carbon arrester at the exchange is not a matter of much importance, because it is easy to replace them quickly, men being always present in the exchange for that purpose. However, all such unwished-for occurrences at the office arrester, even though remedied within a few moments, are likely to cause interruption in the service which, from the subscriber's standpoint, is not desirable. The blowing of a fuse or the operation of a carbon arrester or heat coil at some point in the outside construction or at the subscriber's station is, however, much worse, as the interruption to the service is of longer duration and the cost of repairing is much greater.

It seems evident that there is such a thing as overdoing protection, as too perfect a system, considered from the standpoint of protection alone, brings about an increased cost for maintenance and frequent interruptions of service. If the cost of protection, due to added maintenance and service interruption, is greater than the gain due to the saving afforded by the protection, then there is too much protection. For this reason a middle course is usually pursued, aiming to give sufficient protection to the apparatus and property to prevent the possibility of any far-reaching disastrous results, at the same time keeping in mind the minimizing of the cost of maintenance and of service interruption.

A typical telephone line for this discussion may be taken as one extending from the central office to a subscriber's instrument, this line passing directly from the office through a section of underground cable, thence through a section of overhead cable, and thence through bare wires on poles to the subscriber's premises. The underground cable, it is understood,

runs directly into the central office, being terminated either in potheads or equivalents, or directly on the line side of the distributing frame, so that there are practically no points, between the place where the cables enter the underground conduits and the inside wiring of the central office, at which the conductors are liable to become crossed with wires charged to dangerous potentials. This portion of the line, therefore, may be fairly assumed to offer no points of exposure to danger, although, of course, danger may be transmitted to it from other portions of the line.

At the point in the office where the conductor emerges from the cable, it is common practice to provide a combined carbon and heat-coil arrester. The coil is so arranged that when released it will allow the line spring to make contact with the ground connection, grounding the line and opening the circuit to the switchboard.

That the central office protection on the line in question should consist of a heat coil and carbon arrester is a matter concerning which there is a little dispute. There are those who maintain that a line when entirely underground from the central office to the subscriber's premises has no need of any protection whatever.

The degree of sensitiveness of the heat coil can not be specified for all cases, as the apparatus of some switchboard systems is very much more susceptible to damage by excessive currents than others. In other words, currents which would be excessive for the electromagnets of some systems would be carried readily without danger of harm by those of others. It may be said in this connection that the best switchboard designers are making the coils of electromagnets, as far as possible, self-protecting; so that they would not be damaged by any current due to the voltage of a central office battery which might flow through them, even on a short circuit. With such apparatus there seems no doubt that an all underground line may be left without protection.

The electromagnets of some switchboards are wound with such fine wire as to render the following requirements of the heat coil necessary: that it shall carry 0.1 ampere indefinitely and operate on 0.2 ampere within five minutes. To meet these requirements the heat coil is generally wound to about twenty-ohms resistance. In other cases the requirements are that the coil shall stand 0.2 ampere indefinitely and that it must operate on 0.25 ampere within three minutes, and that the resistance of the coil shall not be more than seven and one-half ohms. These latter figures are now perhaps the most commonly adopted, and with such a coil when the current is in excess of one-quarter of an ampere but less than 0.4 of an ampere the coil will operate in from one to one and one-quarter minutes; and with currents in excess of 0.4 of an ampere they are operated practically instantaneously.

The air-gap betwen the arrester blocks at the central office is now fairly well standardized at 0.005 inch, and with such an air-gap and with carbon of ordinary grade the insulation between the blocks will break down when subjected to a tension of about 350 volts.

The question as to whether a fuse should be placed at the point where an underground cable joins an aerial cable is a mooted one. It is probably true that as in many other disputed questions there are good reasons on both sides and that under some conditions a fuse should be placed at this point, while under others it should not. Pure logic certainly brings us to the conclusion that a fuse should be placed at a point on the line where the exposed construction begins. This being true, the placing of fuses in the conductors at the point where the aerial cable passes to the underground cable, depends on whether or not the aerial cable may be considered as, within itself, exposed. Clearly, a high-tension wire falling across or in any other way coming in contact with an aerial telephone cable, is a possible occurrence. It is also clear that such a cross might cause the speedy disintegration of the sheath of the cable and thus direct exposure to the conductors within. In this sense the aerial cable is exposed to danger and to protect the underground conductors from damage due to such a contingency, it would be necessary to place fuses at the outer end of the underground cable.

While every telephone man who has had experience with outside construction will probably call to mind one or a few cases where damage to aerial cables—and through them to underground cables—has occurred, due to exposure at some point within the aerial cable, it is probably true that the cases that one man is able to cite are few. Certainly aerial cables are often damaged, due to high-tension crosses or to lightning, but in many of these cases of damage the doubt exists as to whether the trouble originated at some point along the line of the aerial cable or whether it originated elsewhere and was brought into the aerial cable conductors through the lines leading to those conductors. Many cases of damage to aerial cables, and through them to underground cables, which at first sight appeared to be clearly due to some conditions along the line of the aerial cable, have afterwards proved to be due to conditions existing beyond it, where the conductors of the circuits were more exposed to trouble.

Perhaps the best answer to the question arising as to the location of fuses at the outer end of the underground construction is that unless the aerial cable traverses a route such that high-tension crosses are very likely to occur along the line of the cable, the aerial cable may be fairly considered as an unexposed portion of the lines; and this conclusion brings us unalterably to the conclusion that the fuse should be at least carried to the outer end of the aerial cable. In those special cases where the danger arising along the line of the aerial cable seems great, then only should a fuse be inserted between the underground and overhead cables.

We have now arrived at the conclusion that in most cases the line fuse should be moved at least as far from the central office as the end of the aerial cable. What should be done at this point?

Clearly, the bare wire joining the aerial cable and the drop wires serving the subscribers are exposed portions of the circuit. To provide, therefore, against heavy currents due to crosses being carried into the cable conductors, a fuse should be placed at the outer end of the aerial cable. If the line be such a one that the underground cable joins directly to the bare wire, then the fuse should be placed at the end of the underground cable. We may say, therefore, that a fuse always should be placed between the exposed and unexposed portions of the circuit.

The fuse at such point provides only for the interruption of strong currents. It does not provide against static discharge. For this reason it follows that in the case of all long aerial lines, such as toll lines, country lines and long bare city lines, a carbon arrester should be added as a protective means at the point where the bare wire arrives at the outer end of the cable. These carbon arresters, owing to their comparative inaccessibility, should be provided with a wider air-gap than is used in the central office arresters, and probably from 0.01 to 0.015 inch represents about the best practice in this respect. The question as to the relative position of the fuse and the carbon arresters now arises. It is evident that if the fuse were placed in the circuit be-

tween the carbon arrester and the central office of a high-tension cross on the exposed portion of the line beyond the carbon arrester might cause an arc in the arrester which would persist, if the cross persisted, and gradually consume the carbons and perhaps incidentally also the cable box, pole fixture and pole. The fuse, therefore, should be placed between the carbon arrester and the outer end of the line and never between the carbon arrester and the cable.

The carbon arresters in such cases protects the cable from lightning and other high-tension crosses, while the fuse not only prevents a heavy current from entering the cable conductors, but also prevents the continuance of arcing at the arresters which might lead to the damage of the equipment at that point.

We may then decide that at least a fuse is required at the point where the overhead cable joins the bare wire or where an underground cable is connected to a bare wire without the intervention of an aerial cable. Also, wherever a long open wire line joins a cable at such a point, a carbon arrester also should be employed.

Some engineers use a carbon arrester as well as a fuse at all points of juncture between open wire and cable, regardless of the length of line. This seems poor policy and one that is productive of excessive maintenance expense. In other words, practice has proven in general that the occasional loss due to damaged cables caused by the omission of carbon blocks, where the open-wire lines are short, is of less importance than would be the maintenance of such blocks at all points where the open wire joins the cable.

Probably all telephone engineers agree that a fuse should be placed at the points where the line wire enters the subscriber's premises. Many complete telephones are now equipped with fairly efficient forms of carbon lightning arresters, these latter forming integral parts of the telephone as produced. The combination of the fuse and the arresters, therefore, forms a very efficient protection for the instrument, the premises and in fact for the line conductor itself. The carbon blocks under any circumstances should never be used without the fuse outside, as a dangerous fire may result from arcing. For this reason the indiscriminate placing of carbon arresters on telephone instruments by the manufacturers is to be deplored.

Some companies add a heat coil to the protective device at the subscriber's premises, but this is thought not to be in accordance with the best practice. The cost of burnt-out telephones which may be saved by the presence of a heat coil probably would prove much less than the cost of time and labor of replacing heat coils at the subscriber's stations.

Municipal Electric Lighting in Great Britain.

The operation of municipal electric lighting plants by local authorities in England is the settled policy of that nation, if one may judge by the figures, which show that such plants are almost uniformly advantageous to the ratepayer, and that the proportion of plants owned and conducted by local authorities to those operated by companies is 323 to 145. In the United States, there are about 1,000 municipally owned electric lighting plants, but many of them are in minor towns, so that the capital invested does not total a very great sum. A table has been compiled, showing the population, capital outlay, total receipts, working expenses and net receipts of the English plants. In the entire list, only one city shows a loss in the operation of the lighting plants on account of the working expenses exceeding the total receipts.

Town.	Population.	Capital Outlay.	Total Receipts.	Working Expenses.	Net Receipts.
Aberdeen	157,000	$970,395	$147,555	$67,995	$79,560
Belfast	349,000	1,108,590	112,520	45,775	66,745
Birkenhead	117,000	466,720	46,675	17,395	29,280
Birmingham	522,200	294,165	336,390	163,245	173,145
Bradford	281,800	2,148,840	330,960	142,115	188,845
Bristol	328,800	2,266,450	256,865	121,040	135,825
Cardiff	164,300	787,805	103,455	50,305	53,150
Croydon	141,200	1,156,715	194,340	103,595	90,745
Dublin	289,100	1,295,375	75,325	45,540	29,785
Glasgow	800,000	5,208,730	622,225	242,900	379,325
Hull	240,600	1,262,730	161,105	82,065	79,040
Islington	335,000	1,943,350	211,025	133,120	77,905
Leeds	437,300	3,357,060	283,280	82,330	200,950
Leicester	211,600	1,081,160	121,880	43,205	78,675
Manchester	659,100	8,568,135	985,845	561,580	424,265
Salford	221,000	2,454,805	226,120	92,490	133,630
Sheffield	412,000	3,084,970	236,000	78,770	157,230
West Ham	267,300	925,845	125,285	77,920	47,365

In England the supply of electricity, both by municipalities and companies, excepting in special cases, is regulated by the electric lighting acts of 1882 and 1888 and the Electric Lighting Act of 1899. The last mentioned act consolidates all the important clauses which have been introduced into the provisional order. The provisional order confers on the owners the right to supply electricity in any given area. It is granted by the Board of Trade and is confirmed by an act of Parliament, when it becomes an effective "order." The possession of an order has generally been regarded as the ownership of a monopoly of supply in the case of municipalities, and also as a matter of practice, of companies, except in London. Orders are granted in perpetuity, but in the case of company orders the local authority of the area supplied is given the right of acquiring the undertaking at the end of forty-two years, provision being made for the manner of such acquiring. The local authorities may buy out the companies by arrangement before the period of forty-two years, and there are many instances in which local authorities have arranged for earlier terms of purchase than those specified in the act.

The system of supply must be sanctioned by the Board of Trade before the supply is started. The current may be charged for on several methods, which must be approved by the Board of Trade. The maximum charge is usually thirty-six cents per Board of Trade unit, which is equal to 1,000 watt-hours.

The cost of lighting in a number of the larger towns is as follows:

The only town that showed a loss was Whiting, with a population of 11,800; the capital outlay was $109,505, total receipts, $4,430, working expenses, $6,320. The total loss was $1,890.—*Municipal Journal and Engineer, December.*

Royal Favors to Distinguished Scientists.

On the occasion of King Edward's birthday, honors were conferred upon a number of distinguished men of science. Among these were Dr. J. W. Swan, who received the honor of knighthood, and the Hon. C. A. Parsons, who was appointed Companion of the Order of the Bath.

Northwestern Electrical Association.

The next annual convention of the Northwestern Electrical Association will be held in Milwaukee, Wis., commencing on Wednesday, January 18, 1905. The president of the association is T. F. Grover, Fond du Lac, Wis., and the secretary and treasurer is Thomas R. Mercein, Milwaukee, Wis.

The Convention of the Interstate Independent Telephone Association.

The annual convention of the Interstate Independent Telephone Association will be held at Chicago, Ill., December 13, 14 and 15, 1904. The headquarters of the association will be at the Auditorium Hotel.

This association was organized in Chicago, Ill., April 9, 1902. Meetings have been held each year, in December, since that time.

At the time of the convention business reports will be received from various committees, and the future of independent telephony will be discussed.

The following programme has been announced:

Tuesday morning, December 13, a reception to members and others by the executive committee and officers, will be held at the secretary's headquarters from 9 to 12.

HENRY A. BARNHART, PRESIDENT, INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

Tuesday afternoon, December 13, at two o'clock—President's annual address, Hon. Henry A. Barnhart, Rochester, Ind. Report of the secretary, E. M. Coleman, Louisville, Ky. Committee reports. Express committee, George N. Bandy, chairman, Des Moines, Iowa. Freight rates, Theodore Gary, chairman, Macon, Mo. Railroads, F. W. Buffom, chairman, Louisiana, Mo. Committee on Postmaster-General Payne's order, L. L. C. Brooks, chairman, Minneapolis, Minn. Special committee on uniformity of equipment and standardization of apparatus, Senator Charles E. Hull, chairman, Salem, Ill.

Wednesday morning, December 14, the officers and executive board will take charge of the delegates from nine to twelve.

Wednesday, December 14, 2 P. M., the following papers will be read: "Why Independent Telephone Securities Do Not Command the Market Price They Deserve, According to Their Earning Capacity," O. M. Bake, vice-president, Miami National Bank, Hamilton, Ohio; "What the Independent Telephone Companies Owe the Public; What the Public Owes the Independent Telephone Companies," Theodore Thorward, president, Indiana Independent Telephone Association, South Bend, Ind.; "Manufacturers' Duties and Their Dues," E. D. Graham, president, Mexico Telephone Company, Mexico, Mo.; "Uniformity of Equipment and Standardization of Apparatus, the Imperative Demand in the Operating

E. M. COLEMAN, SECRETARY, INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

Field," J. H. James, president, Minnesota Independent Telephone Association, Mankato, Minn.

Thursday, December 15, 9 A. M., the following papers will be read: "The Importance of Bringing About, by Legislation or Otherwise, Uniform Telephone Rates for Exchange Service in Towns of the Same Size; Also Uniform Toll Rates," E. H. Moulton, president, Twin City Telephone Company, Minneapolis, Minn.; "How to Avoid Personal Injury and Responsibility in Telephone Construction Work and Maintenance," Senator Rome C. Stephenson, Rochester, Ind.; "Where Are We? How Did We Get There? What of the Future?" A. C. Davis, manager, Parkersburg Telephone Company, Parkersburg, W. Va.; "The Evils of Connecting with the Bell," P. H. Holdoegel, Rockwell City, Iowa.

Thursday, December 15, two o'clock, there will be an entertainment of the attending delegates in charge of the officers and executive board.

On the evening of Thursday, December 15, there will be a banquet, followed by a vaudeville concert.

The officers of the Interstate Independent Telephone Association are: president, Henry A. Barnhart, Rochester, Ind.; vice-president, E. H. Moulton, Minneapolis, Minn.; secretary, E. M. Coleman, Louisville, Ky.; treasurer, A. B. Conklin, Aurora, Ill.

Banquet of the New York Edison Company Agents and Inspectors.

On Tuesday evening, November 29, the New York Edison Company tendered a banquet to its agents and inspectors at the Hotel St. Denis. Besides the officers of the company more than eighty members of the contract and inspection department were present. At the speakers' table were Nicholas F. Brady, Thomas E. Murray, J. W. Lieb, Jr., A. A. Pope, C. A. Littlefield, R. U. Conger, of the Sheldon School of Scientific Salesmanship, and Arthur Williams, who presided.

Mr. Lieb was introduced as the first speaker of the evening. In making the introduction, Mr. Williams rehearsed the development of the company from the time when the entire territory supplied covered less than one square mile; when there were less than 300 customers, and when there were no arc lamps. To-day the territory exceeded seventeen square miles and there were 34,000 customers and about 23,000 arc lamps. At the present time there was 90,000 horsepower in motors engaged in every industry in New York city in which mechanical

A. B. CONKLIN, TREASURER, INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

power is used. The customers of the company during the last five years have increased from 16,000 to the present number. The number of incandescent lamps installed has increased from 750,000 to 1,600,000, and the arc lamps from 10,000 to the present number.

In his remarks, Mr. Lieb referred to the early history of the lighting industry of New York city, and sketched the change in policy of electric light companies and gas companies, and the vigorous methods pursued for the securing of new business. He recognized the necessity of the various departments of the company meeting from time to time in order to discuss and compare notes. He mentioned the very successful work performed by the Bulletin issued by the advertising department of the company.

Mr. Conger was the next speaker, and he dwelt upon the educational effort that the correspondence schools of the country were making and the part they were playing in the development of salesmen of a high order of ability.

Convention of the National Electric Light Association.

Denver and Colorado Springs, Col., have been selected for the twenty-eighth convention of the National Electric Light Association. Denver will be given three days and Colorado Springs a like number, it being the purpose to hold three sessions each day. Colorado Springs, however, will be given over more largely to sight-seeing, while Denver will be the scene of the business sessions.

The full list of committees appointed at the meeting recently held at Denver, Col., is as follows:

General Arrangement Committee—Orson Adams, Grand Junction Electric and Gas Company, Grand Junction; William Mayher, Greeley Power and Light Company, Greeley; W. E. Renshaw, Seaton Mountain Electric Light, Heat and Power Company, Idaho Springs; F. C. Webber, Leadville Gas and Electric Company, Leadville; P. N. Munn, Telluride Power Company, Provo, Utah; R. S. Campbell, Utah Light and Railway Company, Salt Lake City; John Martin, California Gas and Electric Company, A. Pollock, San Francisco Gas and Electric Company, San Francisco, Cal.; F. E. Warren, Cheyenne Fuel and Power Company, Cheyenne, Wyo.; C. F. Brown, Roaring Fork Electric Light and Power Company, Aspen; William T. Wallace, Colorado Electric Power Company, Canon City; Herman Webber, La Bella Electric Company, Cripple Creek; C. H. Peters, Durango Light and Power Company, Durango; George B. Tripp, Colorado Springs Electric Company, Colorado Springs; Charles Neeley, Fremont Electric Light Company, Florence; M. T. Morrill, Electric Light Company, Golden; F. P. Dewey, Electric Light Company, Georgetown; General Fred Walsen, Electric Light Company, Idaho Springs; H. R. Wray, Chamber of Commerce, Colorado Springs; J. F. Vail, Electric Light Company, Pueblo; E. J. Temple, Electric Light Company, Boulder; D. O. Freyberger, Electric Light Company, Loveland; John Doss, Electric Light Company, Ouray; C. Y. Breck, Telluride Electric Light and Power Company, Telluride; Nelson Rhoades, Arapahoe Electric Light and Power Company, Littleton; W. F. Jones, Gold Belt Consolidated Electric Company, Victor; J. B. Wiggenhorn, Florence & Cripple Creek Company, Cripple Creek; G. E. Sethman, Meeker Light, Heat and Power Company; C. W. Badgley, Crested Butte Light and Water Company; Irving Hale, General Electric Company; O. B. Kohl, Lacombe Electric Company; John Brannan, Lacombe Electric Company; William S. Iliff; C. K. Durbin; J. H. Waters, La Bella Electric Company; S. W. Cantril, Denver Tramway Company; George W. Cook; J. A. Beeler, Denver Tramway Company; J. J. Hernan, Hotel Men's Association; N. M. Tabor, Hotel Men's Association; Armour C. Anderson, Real Estate Exchange; John McNamara, Real Estate Exchange; J. S. Temple, Chamber of Commerce; Arthur Williams, Chamber of Commerce; T. B. Stearns, Stearns-Rogers Manufacturing Company; Major S. K. Hooper, D. & R. G. Railway; J. F. Vallery, Burlington Railway; William E. Bridgman, H. J. Mayham Investment Company; James Williams; E. R. Griffin, Union Pacific Railway; J. J. Joslin, Merchants' Protective Association; C. L. Wellington, Rock Island Railway; David H. Hoops, Chicago & Northwestern Railway; George W. Vallery, Colorado Midland Railway; H. B. Kooser, Missouri Pacific Railway; George Gano, Merchants' Protective Association; W. J. Jones, Denver & Northwestern Railway; Charles B. Sloat, Rock Island Railway; J. P. Hall, Santa Fe Railway; D. C. McWatters, Cripple Creek Short Line; Fred H. Bostwick; J. C. Poole, Stanley Electric Company; H. L. Woolfenden, Gilbert Wilkes and Company, R. D. Marthens, Nernst Lamp Company; R. W. Speer, mayor; E. S. Kassler, Montrose Electric Light and Power Company; J. J. Cooper, Mountain Electric Company; J. W. Stearns, Mountain Electric Company; Edward C. Means, Adams-Bagnall Electric Company; Thomas Smith; Edward Pool, American Steel and Wire Company; J. D. Jackson, Western Electric Company; W. P. Carstarphen, Carstarphen Electric Company; H. W. Lawrence, New England Electric Company; J. J. Henry; P. J. Brown, General Electric Company; B. K. Sweeney; R. E. Miller, Crocker-Wheeler Company; Charles S. Onderdonk, Onderdonk Manufacturing Company; R. B. Sullivan, Frank W. Frueauff, Henry L. Doherty, C. W. Humphrey, W. J. Barker, E. Y. Sayer, C. N. Stannard, Rufe Gentry, John Craig Hammond, J. Chas. Andrews, Denver Gas and Electric Company; William Maher; J. F. Callbreath, Chamber of Commerce; A. R. Hall, Capital Lamp Company; C. H. Speers, Colorado Midland Railway, Denver, Col.

Executive Committee—Henry L. Doherty, chairman; F. W. Frueauff, vice-chairman; George B. Tripp, H. R. Wray, J. A. Beeler, T. B. Stearns, J. F. Callbreath, Armour C. Anderson, General Fred Walsen, J. Chas. Andrews, secretary.

Transportation Committee—George W. Cook, chairman; J. S. Temple, Major S. K. Hooper, J. F. Vallery, E. R. Griffin, H. R. Wray, C. L. Wellington, George F. Porter, master of transportation, National Electric Light Association; J. Andrews, secretary.

Finance Committee—George W. Gano, chairman; George B. Tripp, vice-chairman; General Irving Hale, J. W. Stearns, C. K. Durbin, J. A. Beeler, J. J. Hernan, J. F. Callbreath, Armour C. Anderson, General Fred Walsen, John Craig Hammond, George W. Cook, J. H. Waters, J. C. Andrews, secretary.

Entertainment Committee—Philip Cross, chairman; F. W. Frueauff, William E. Bridgman, T. B. Stearns, George W. Vallery, George B. Tripp, H. R. Wray, R. W. Speer, General Fred Walsen, J. C. Andrews, secretary.

Advertising Committee—John Craig Hammond, chairman; John McNamara, T. E. Fisher, S. K. Hooper, J. F. Vallery, N. M. Tabor, David H. Hoops, J. J. Joslin, D. C. MacWatters, Charles B. Sloat, J. C. Andrews, secretary.

Colorado Springs Local Committee—George B. Tripp, H. R. Wray.

Hotel Committee—W. J. Barker, chairman; J. J. Hernan, J. J. Cooper, J. F. Vail, S. W. Cantril, H. L. Woolfenden, Philip Cross, J. C. Andrews, secretary.

GAS AND ELECTRIC REPRESENTATIVES AT RECENT MEETING, AT DENVER, COL.

Left to Right. Upper Row—R. B. Sullivan, J. C. Andrews, F. W. Frueauff, Harry C. Abell, M. R. Bump, Ernest Isenbach, C. N. Stannard, M. E. Malone, Phillip Cross.
Lower Row—J. R. Hunting, W. B. Tuttle, Henry L. Doherty and R. B. Brown.

Extent of Telephone Service.

The Bell Telephone Company, in its annual report, states that on January 1, 1904, it had 130,138 miles of pole line and 975,702 miles of wire. 26,128 cities and towns are connected by these lines. During the year of 1903, the company transmitted 83,000,000 long distances messages. The total number of messages transmitted by all lines, including local messages, was 3,263,000,000. The report further states that at the end of the year 1903, there was one telephone to every fifty-three people in the country, the total number of subscribers being 1,525,167. The number of employés was 61,135, and the length of wires in the various exchanges was 2,938,189 miles. The total mileage wire, including long distance and exchange wires, was about 4,000,000 miles.

Mr. William Barclay Parsons Resigns from the Rapid Transit Board.

Mr. William Barclay Parsons, who has been chief engineer to the Rapid Transit Commission, New York city, for more than ten years, has resigned this post. Mr. Parsons, more than a year ago, announced that he would probably resign as soon as trains began running in the subway, when he would look upon his work as completed. Mr. Parsons will continue to advise the board in a consulting capacity. Mr. George S. Rice is deputy chief engineer.

GROUNDED TRANSMISSION MEDIUMS—III.

BY J. STANLEY RICHMOND.

TRACK DROPS—COMPARATIVE SIMULTANEOUS VOLTAGES OF DIFFERENT POINTS.

It is very necessary not only to assist in making surveys but also to keep check on the condition of the tracks from a conductivity point of view, after they have once been placed in good order, that some arrangement should be made whereby the voltages of different points of the low-voltage side of a system can be simultaneously taken at least once a month.

For this purpose, the writer once designed a rather complete set of apparatus, consisting, in the main, of one special switchboard for the telephone central office and subsidiary apparatus for each point of the system chosen as suitable to know the voltage of.

Fig. 15 is a reduction of a drawing of such special board, which consists of a substantially made frame box with the back removable and two glass doors so hinged in front that they can be locked in the centre. The switchboard proper is built of three sheets of hard rubber fastened down around the edges by countersunk flat-head brass screws to an inner-projecting portion of the frame. On these sheets are mounted five rows of twenty-four double-pole, double-throw switches with one plug below each switch. Through the bottom of the frame run twelve flexible cords, to the inner end of each of which is attached a small socket made to fit the plugs under each switch, and to the outer end of each of which is connected a suitable meter terminal. The wiring is on the back of the board (between the rubber sheets and the removable back) and consists of small rubber-covered wires formed and stitched on the principle similar to that adopted in telephone practice. One bunch of formed wires constitutes the incoming cable and the other bunch the outgoing cable.

To connect this special board up, the required telephone wires are cut between the distributing rack and the switchboard of the telephone exchange; and the ends from the distributing rack are connected to the incoming cable of the special board, while the ends from the telephone switchboard are connected to the outgoing cable of the special board. The two wires of each pair of the incoming cable are connected to the middle points of their particular switch, to the upper points of which switch are connected the two wires of the corresponding pair in the outgoing cable. Each switch has its bottom points connected in multiple to the plug mounted below it. The details of the wiring and the other parts will be understood after examining the detail drawings in Fig. 15. Thus, when all the switches are up, the telephone wires are in regular service; while, when down, each pair of wires will be in multiple with one of the small plugs and the telephone service cut out.

Fig. 16 is a drawing showing the subsidiary apparatus. This consists of a small box, the upper part of which contains a sheet of hard rubber on which is mounted one double-pole, double-throw switch. One of these is placed alongside of each telephone located nearest to the point of the track of which a reading of the voltage is required. To connect up this subsidiary apparatus, the line wires are cut at each point near the telephone and the line ends are then connected to the middle points of the switches, the upper points of which switches are connected to the line posts of the telephones. Each box has a lower compartment lined with asbestos and divided in the centre with a piece of leatheroid (fibre); and in each of the divisions so formed is mounted a binding-post with a fuse wire between them. In practice, the writer has found that this fuse is not necessary, but it is provided to allay the fears of telephone officials. The first binding-post in each box is connected by a wire or strip to the lower points of the switch and the second one to the nearest track bond. If two connections (two points to take readings of) are required at any one of the stations, the second binding-post is connected to the middle point of a single-pole double-throw switch mounted alongside of the double-throw one, the top point of which is connected to the nearest track bond and

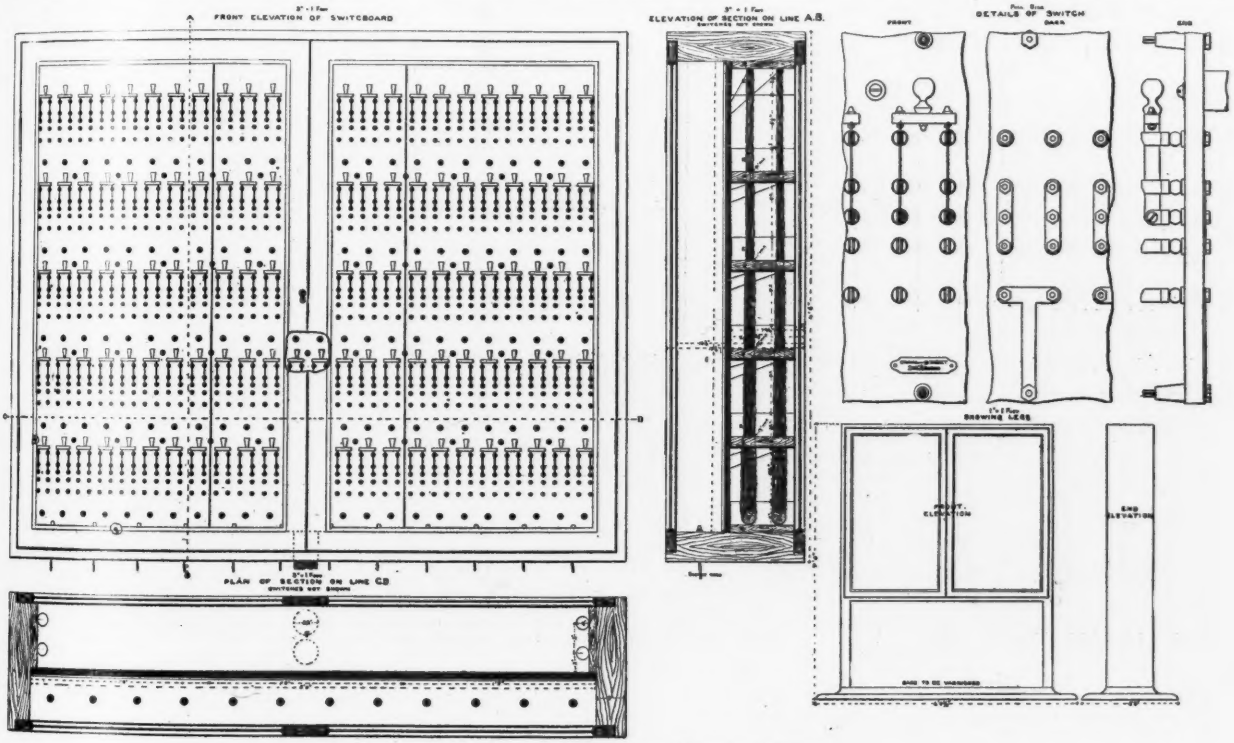


FIG. 15.—CENTRAL SWITCHBOARD TESTING SYSTEM.

the lower point to the other point desired. To use the apparatus which has been described, the *modus operandi* is as follows: eleven below-and-above-zero-reading potential meters (Richmond pattern) are placed on a table near to the special board, and all the zero posts connected to one of the flexible cords at the bottom of the special board. The plug on the other end of this cord is forced on to the socket below the switch which is connected to the wires from the power-house telephone; the switch of the subsidiary apparatus alongside which telephone has its lower points connected to the low-voltage bus-bars instead of to the nearest track bond. This power-house line, when the readings are being taken, becomes the zero wire. The other eleven cords, after their socket ends have been forced on the plugs belonging to the switches controlling the points at which voltage readings are desired, are connected one to each of the other binding-posts of the meters. The operator at central is then requested by the head reader to call up the twelve points (power-house first) and request them to throw their double-throw switches down, to stay by them for fifteen minutes and then throw them up again. When she has received favorable answers, she so notifies the head reader who immediately throws down the corresponding twelve switches on the special board. Then, calling his eleven assistant readers to order and with watch in hand, he waits until the second hand reaches the minute, when in a clear, loud voice he says "now," repeating the word every ten seconds for two or three minutes. Every time he says "now" each assistant notes the deflection of his meter needle and jots such down consecutively on the sheet provided, and which is ruled with spaced columns, ten spaces to each column. At each minute, the head reader says immediately after the word "now" the word "minute," by which the assistants know that the reading which they are entering must come in a space at the head of one of the columns. This, in case an assistant has skipped the entering of one reading; and so that all his readings, thereby, may not become valueless.

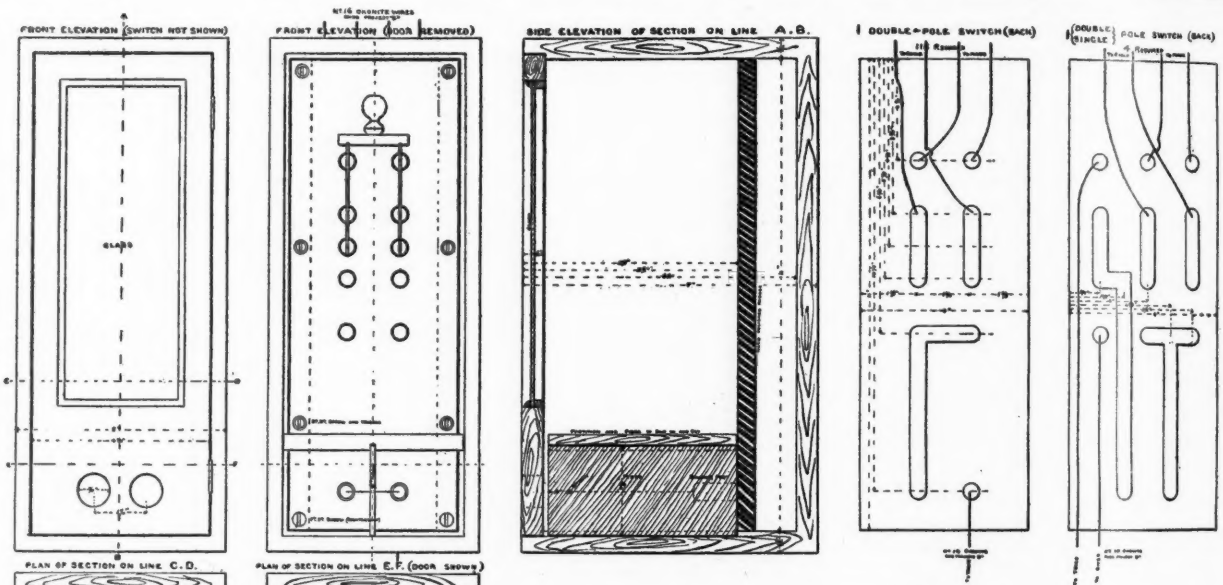

FRONT ELEVATION (SWITCH NOT SHOWN)
FRONT ELEVATION (DOOR REMOVED)
SIDE ELEVATION OF SECTION ON LINE A.B.
DOUBLE-POLE SWITCH (BACK)
PLAN OF SECTION ON LINE C.D.
PLAN OF SECTION ON LINE E.F. (DOOR SHOWN)

FIG. 16.—STATION SWITCH AND FUSE BOXES, TESTING SYSTEM.

After the readings have been all taken, the head reader immediately throws up the twelve switches on the special board, and notifies the operator at central that he has finished, who after the fifteen minutes have elapsed takes the trouble to call up the twelve points and find out whether they have or have not thrown up their switches as requested. In case of any special emergency, any one of the attendants at any one of the twelve points can obtain telephonic communication while the readings are being taken by throwing up his switch. This will stop the deflection of the needle of the potential meter on his line; the assistant reader in charge of which instrument should immediately throw up his switch, whereby central is called in the regular manner.

This class of testing can be easily carried out by any company having a central exchange either of their own or rented from some local telephone company, provided that the instruments operated from it are located at suitable points of their system. Suitable outside telephone points having been chosen, a small double-pole, double-throw porcelain switch (obtainable from any dealer in electrical accessories) is installed near each telephone, and connected up similar to the method before described. At the telephone central the telephone cable is cut and a box with the desired number of similar porcelain switches (about twelve, as a rule), installed in some convenient near-by position, is wired up similar to the manner which has been explained in regard to the special board. Such simple and economical apparatus forms a means whereby these tests, which in the present state of electrical engineering are an absolute necessity, can be easily made at a minimum expenditure.

Referring to the matter contained in the article "Negative Boosters," which appeared in the ELECTRICAL REVIEW, October 8 and 15, 1904, it may not be out of place to say, in the event of there being much insulated cable between the rails and the low-voltage bus-bars, that the lowest voltage point of the rails can, as a rule, be connected to one of the lines, and that such line can be used as the zero wire instead of the one running to the low-voltage bus-bars.

Once the apparatus is installed, tests should be made at frequent intervals, care being taken that the readings are made at similar times of the day (approximately equal load conditions) on each occasion; and if the duties connected with such are controlled by some other department than the one in charge of the bond testing the general manager will find that the information obtained from the readings serve as a very effective check on the bond-test sheets turned in.

PROBLEMS OF HEAVY ELECTRIC TRACTION.[1]

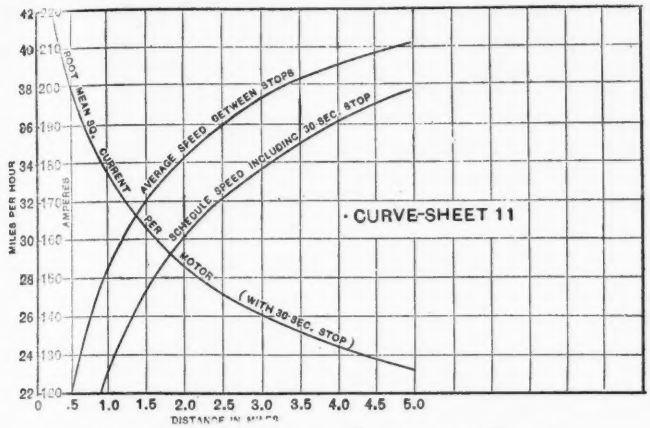
BY O. S. LYFORD, JR., AND W. N. SMITH.

(Concluded.)

II—USE OF TYPICAL RUN CURVES.

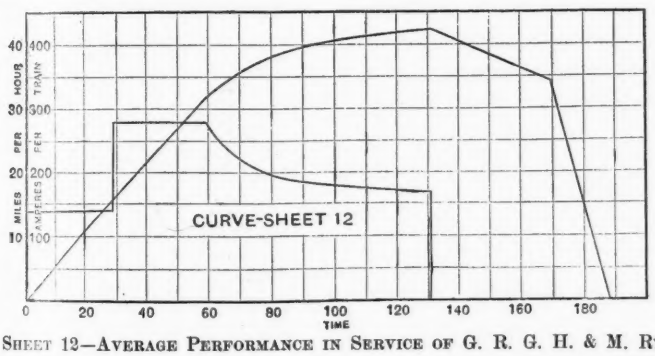
As previously stated, the proposed electrical schedule for the Long Island Railroad provides for a large number of combinations of weights of trains and lengths of run. It is obvious that a tremendous amount of time would be consumed if an attempt were made to plot each of these runs and to make the determinations of schedule speed, power consumption and heating effect for the various types and sizes of motors which might be used. To avoid this expenditure of time it was necessary to adopt certain approximate methods, and one method which was used after verification by a practical comparison is what may be called the "Typical Run Curve."

Disregarding grades and curves, a single run for a distance equal to the average length between stops will represent the conditions pertaining to a through run; by plotting results for such average runs of different lengths, curves are obtained which will give exact results for the actual conditions assumed and approximate results for the varying distances between stops and on a succession of light grades and curves. Curve sheet 11 illustrates the character of the curves obtained in this way.



CURVE SHEET 11—GENERAL PERFORMANCE CURVE.

8-car train for L. I. R. R.; two 44-ton motor cars; one 33-ton trailer car; total weight 121 tons; four No. 86 Westinghouse motors; 23:59 gear ratio; 36-inch wheel; 540 volts; 1.5 miles per hour per second braking; no coasting.



CURVE SHEET 12—AVERAGE PERFORMANCE IN SERVICE OF G. R. G. H. & M. RY. CAR.

Two Westinghouse 50-C. motors; 20:51 gear ratio; 0.55 mile per hr. per sec. initial acc.; 525 volts; 140 amperes per motor starting current; weight 29.5 tons; average grade, level.

	Results. Theoretical.	Observed Average.
	G. R. G. H. & M. Ry.	
Distance, miles	1.54	1.54
Time, seconds	188.0	188 0
Schedule speed miles per hour	29.5	29 5
Kilowatt-hours	3.84	3.65
Watt-hours per ton-mile	84.5	80.3
Root mean square current, amperes	95.6	

Smith formula.

The principal question involved as to the propriety of such a typical run curve is whether the result so obtained (by considering the track straight and level and the distance between all stops the same) will agree closely enough with the average of results obtained from plotting the time-speed curves of an entire round trip, taking the grades and curves into account and placing the stops exactly. It would seem reasonable that the effects of grades in one direction should balance those in the opposite direction when calculating the general results of a run plotted for a round trip when the time of a single run is not greater than one hour, as in this case. If the results of train runs plotted complete be compared with typical run curve results, and if this comparison is generally favorable under varying conditions of grade and length of run, it is safe to assume that typical run curves can be used in place of plotted runs for purposes of general estimate and comparison of different types of equipment when operated under similar conditions. The comparisons have, therefore, been made for a given equipment by making plotted runs in opposite directions over the same grades on certain routes of the Long Island Railroad both on the comparatively level runs of the Manhattan Beach and Rockaway Beach divisions and on the more hilly runs from Long Island City to Port Washington. Tables of two of these runs are appended hereto (tables 2 and 3), which give values for the heating effect for individual runs between stops and the average for round trips. It is to be noted in passing that these particular tables represent motor performances that proved too heavy for the motors

TABLE II.

Rockaway Park Division; 77-ton train; two No. 86 motors; 30-second stop; no coasting.

Run.	Length of Run	Square root of mean square current. Plotted Run East	Plotted Run West	Average Plotted Both Ways	Typical Run.
Long Island City					
Bushwick Junction	3 99	154.5	137 3	145.9	147.9
Fresh Pond Junction	.46	223.9	227 0	225 4	226.8
Glendale Junction	1 91	178.2	179 0	178.6	179.3
Brooklyn Hills	.55	241 7	220 5	231 1	213.0
Woodhaven Junction	97	186 5	207 0	196 7	200 2
Ozone Park	30	227 0	274 0	250.5	240.0
Aqueduct	1.34	176.0	192 0	184 0	186.8
Ramblersville	.73	201.5	210 5	206 0	210 0
Howards	.76	209.5	207 0	208.2	209.3
Goose Creek	.93	201 7	200 5	201.1	201.8
The Raunt	96	200.5	209 5	205.1	200 6
Brosst Channel	.83	206 7	203.5	203.1	206 7
Beach Channel	.74	210.5	205.5	208.5	209.9
Hammel	.47	225.0	221.0	228.0	226.0
Hollarid	.39	229.5	210.5	220.0	232.0
Seaside	.49	227 5	224.5	226.0	229.4
Rockaway Park	.75	209.5	209.6	209 5	209.6
Summary for round trip	.948	199.0	201.9	200 45	201.2

TABLE III.

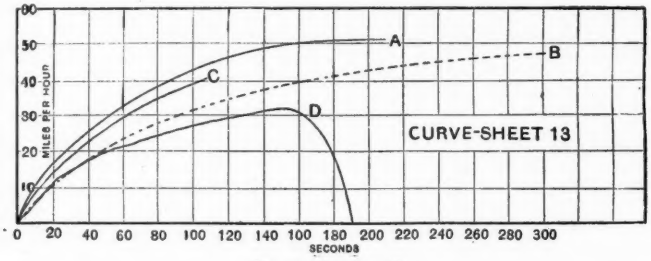
North Side Division; 77-ton train; two No. 86 motors; 30-second stop; no coasting

Run.	Length of Run	Square root of mean square current. Plotted Run East	Plotted Run West	Average Plotted Both Ways	Typical Run.
Long Island City					
Woodside	3.04	165 5	150.1	157 8	156.
Winfield	1.00	194 0	202 7	198.3	199
Elmhurst	.81	210.5	202.0	206.2	207.
Corona	92	215.0	210.0	212.5	202.
Whitestone Junction	1 20	179 8	195.8	187.8	191.5
Flushing, Main Street	1.08	209.9	195.0	202.4	171.5
Murray Hill	.90	227.0	195.5	216.2	202.
Broadway	.84	223.9	219.0	220.5	221.
Auburndale	.78	224.0	228.0	225.0	208.
Bayside	.97	208.5	202.0	205.7	200.
Douglaston	1.36	174.0	186.0	180.0	180.3
Little Neck	.55	233.0	225.0	229.0	220.5
Great Neck	1.24	199.3	165.8	182.4	190.
Manhasset	1.53	202.5	202.0	202.4	181.3
Port Washington	2.66	168.0	198.0	183.0	180.5
Average sq. root mean sq. for whole run	1.20	198.0	191.5	195.0	191.0
Average schedule speed miles per hr.		24.2	24.0	24.85	24.

[1] A paper presented at the 191st meeting of the American Institute of Electrical Engineers, New York, November 25, 1904.

and had to be abandoned. They, however, illustrate the point under discussion.

These runs were calculated for the purpose of comparing the determination of square root of mean square current. It is possible to make similar comparisons for kilowatt-hours per car-mile and watt-hours per ton-mile, but it is safe to assume that a check made on the comparative determinations for square root of mean square current will indicate the correctness of the assumptions for the determination of the other requirements.



CURVE SHEET 13.

Time-Speed Curve of 3-Car Steam Train. A—From best locomotive performance reduced to level. Weight of train, including locomotive No. 59, 171.9 tons, disregarding light live load. Weight of locomotive, including tender, 88 5 tons. Weight on drivers, 37 5 tons.

Time-Speed Curve of 5-Car Steam Train. B—From best locomotive performance reduced to level. Weight of train, including locomotive No. 64, 232.6 tons, disregarding light live load.

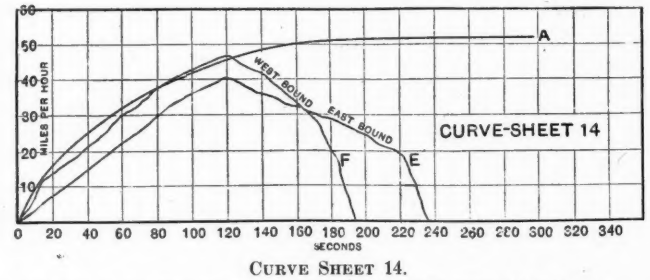
Time-Speed Curve of 3-Car Steam Train. C—From actual run made on a level. Weight of train, including locomotive No. 72, 175.1 tons, disregarding light live load.

Time-Speed Curve of 5-Car Steam Train. D—From actual run made on a level. Weight of train, including locomotive, No. 64, 232.6 tons, disregarding light live load.

In general it will be noted that the differences between typical run results and the plotted runs, even in the case of the North Side Division, on which conditions of grade are more severe, do not exceed five per cent for the square root of mean square current and about four per cent for speed. This would seem to be sufficiently close for practical purposes in making estimates for given equipment operated over runs of varying lengths where grades are so comparatively light as in the case of the Long Island Railroad.

A verification of the accuracy of this method for power determinations in service on an interurban road of the normal amount of curvature in a comparatively level country is obtained by plotting an average run for the G. R. G. H. & M. road, curve sheet 12 shows a run plotted for the same distance, time, initial acceleration, and percentage of time coasting and braking as averaged on a round trip service run of a single car of the G. R. G. H. & M. Ry. outside of terminal cities. The tabulated data on this sheet show that the watt-hours per ton-mile were within six per cent of the same value for the theoretical average as for the observed average of an actual test.

The foregoing examples demonstrate that for preliminary determinations of motor characteristics, reasonably close results are obtained by this method, except possibly where very unusual conditions exist. No claim is made that the method is new; in fact it is quite generally used. The data given simply show that under ordinary circumstances it is reasonable to use this short method and thus dispense with a vast amount of tedious calculating.



CURVE SHEET 14.

Time Speed Curve of 3-Car Steam Train. A—Taken from curve sheet No. 13.

Time Speed Curve of 5-Car Steam Train. E—From College Point to Whitestone, made by 5-car steam train. Weight, including locomotive No. 18, 276.1 tons, disregarding small live load. Acceleration made on average grade of –0.78 per cent.

Time Speed Curve of 3-Car Steam Train. F—From Whitestone to College Point, made by 3-car steam train. Weight, including locomotive No. 35, 162.85 tons, disregarding small live load. Acceleration made on average grade of –0.74 per cent.

III—SCHEDULE SPEED REQUIREMENTS AND LIMITATIONS.

The operating conditions of a large steam railroad introduce limitations which cut down the possible speed of the motive power equipment. Many of these are conditions over which the engine man has no control and which do not relate to the nature of the equipment; that is, curves, road crossings, junction points, yard limitations, meeting points on single track lines, time to handle baggage and express matter, etc. There are delays at stations and delays during runs, some of which occur regularly, but many of which are intermittent. Because of the complicated service these delays are greater on the suburban lines of a steam road than usually occur in interurban or elevated electric service. It is, therefore, evident that in the electrical operation of such suburban service the loading of the motors will differ materially from the loading in an ideal run which might be made with the conditions removed.

TABLE IV.

Long Island Railroad; Long Island City to Valley Stream, *via* Far Rockaway, eastbound; length of run, 22.97 miles.

Train Number.	1287	1303	1221	Average
Locomotive number	72	34		
Locomotive weight	179,000	154,500		
Number of cars	3	4	5	4
Total weight of train (tons)	175 1	186 55		
Schedule time of run	56 00	55 00	58 00	56 00
Actual time of run	52 30	74 20	59 00	62 00
Schedule number of stops	0	10	12	10
Actual number of stops	10	11	12	11
Maximum acceleration	.6	7	65	65
Grade on which made	–1 00	–0 08	–0 08	–0 38
Maximum retardation	1 6	1 8	1 9	1 76
Grade on which made	Level	Level	Level	Level
Average acceleration	.47	46	35	429
Average retardation	1 04	1 06	1 22	1.11
Maximum speed	56 5	52 5	50	53
Average length of run	2 08	1 91	1 77	1 92
Average time of run	4 53	4 43	4 10	4 32
Average maximum speed	39 9	34 8	33.5	36.1
Length of longest run	7 77			
Time of longest run	11 20			
Average time of stops	0 49	1 55	0 25	0 63
Average speed between stops	30 8	23 9	25 5	26 5
Possible average speed from curve	34 5	33.7	32.7	33 6
Ratio average to possible average speed	89 4%	71 %	76 %	78.5%

TABLE V.

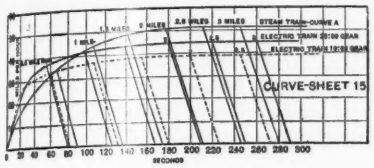
Long Island Railroad; Whitestone Division, westbound; length of run, 11.75 miles.

Train Number.	346	360	348	Average
Locomotive number	59	35	20	
Locomotive weight	177,000	154,500	138,500	
Number of cars	3	3	5	4
Weight of train (tons)	171.9	162 85	217 65	184.2
Schedule time of run	28 00	28 00	31 00	29 00
Actual time of run	28 34	27 34	30 15	30 27
Schedule number of stops	7	7	7	7
Actual number of stops	7	7	7	7
Maximum acceleration	9	95	.5	.78
Grade on which made	–0 65	–0 65	–0 75	–0.68
Maximum retardation	1 8	2 0	1 9	1.9
Grade on which made	1 07	0 69	1 38	1.01
Average acceleration	44	35	29	36
Average retardation	1 43	1 5	1 3	1 38
Maximum speed	52	50	44 5	48 8
Average length of run	1 47	1 47	1 47	1 47
Average time of run	3 08	3 14	3 55	3 26
Average maximum speed	41	38 3	33 5	37 6
Length longest run			1 63	
Time longest run			3 47	
Average time at stops	0 29	0 15	0 33	0 30
Average speed between stops	28.1	27.3	22 5	25 9
Possible average speed from curve	30.6	30.8	30 8	30 8
Ratio actual to possible average speed	91.8%	88.6%	73%	84.2%

After considering various methods of providing for these conditions it was decided to make a series of tests of the present steam equipment to determine the speed time characteristics of the steam trains and the degree to which these characteristics are affected by the local conditions. To this end a test car was equipped with a speed-recording device and runs were made over various routes with this car attached to regular trains. Complete records were obtained of the movement of each train throughout a round trip, and observations made of local conditions which affect speed. These

records were carefully analyzed and the results tabulated. In some instances the engineers were requested to make the best time possible; in other cases they were not advised that a test was in progress.

In summarizing these test runs comparisons were made between the average speed between stops as actually attained and the possible average speed if best acceleration had been made for each run. The character of record obtained is illustrated in tables 4 and 5. It was found that the ratio of the actual speed to the possible speed without local limitations is from 71 to 91.3 per cent. Even when the engineers were requested to do their best they were able in only one or two instances to exceed ninety per cent of the speed which appeared from the test to be possible. On runs 335 and 346 of the Whitestone Division in which locomotive No. 59 made the best single record, the average speed for the run was also nearest to the maximum limit.



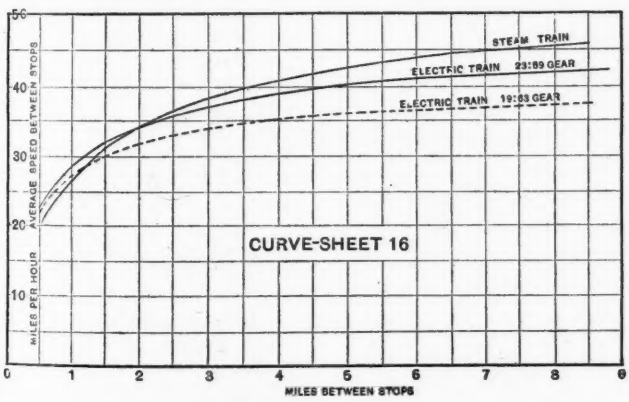
CURVE SHEET 15.

Time-Speed Curve of Steam Train—Curve A of sheet No. 13.
Time-Speed Curves of Proposed Electric Trains—Best possible performance on level grade.
Weight of train, 121 tons, without standing load. (All 3-car trains.)

From these records were selected the four best single accelerations. Curve sheet 13 shows the speed-time characteristics of these accelerations. Curve D illustrates the general character of record made by the instrument in these tests. This run, having been made on a level, conforms exactly with the record obtained.

Curves A, B and C were obtained on grades, and the actual record has been corrected to illustrate the performance of these trains when reduced to a level. In each case the average acceleration over the run was less than the characteristic shows, but these curves illustrate the maximum that the steam equipment was able to do. The composition of trains and their estimated weights are indicated on the curve sheet. The live load on these runs was so light that it was disregarded. On curve sheet 14 will be found two curves (E and F) of actual runs on grades, compared with run A of the curve sheet 13. According to curve E, a five-car train on a down grade was accelerated at a rate far below the best performance and even the three-car train with locomotive No. 35 (curve F) was not accelerated on a down grade with a rate any better than the best single performance on a level.

It will be noted that the curve A was made by a locomotive whose weight was 51.5 per cent of the total weight of train. The officials of the railroad were of the opinion that service equivalent to that which could be performed by this locomotive, No. 59, with only three cars would be sufficient for the electric equipment. The best performance of this locomotive was, therefore, taken as the criterion by which to work in determining the proper characteristics for the electric equipment. The condition laid down was that the electrical equipment, operating a train with standing load in the cars, should be able to make the same average speed between stops as this particular steam equipment.



CURVE SHEET 16.

Speed Limit Curves for 3-Car Trains—Showing best possible speed between stops over various lengths of run, without coasting. Steam train based on curve A for acceleration. Electric train with standing load weighs 121 tons.

Taking curve A as a basis, determinations were made of what may be termed the "speed-limit" for steam trains. This is a curve indicating the average speed in miles per hour between stops with the rate of acceleration corresponding to curve A, without coasting; and with a braking rate of 1.5 miles per hour per second. On curve sheet 15 there will be found a characteristic speed-time curve of this steam train making runs of from one mile to three miles. From this curve the speed-limit of steam trains compares with the average speed between stops required to make various typical runs of the proposed suburban service. It will be noted that the average speed of the schedule runs is from 71.2 to 92 per cent of the speed limit with about eighty per cent as a mean figure.

SCHEDULE CONDITIONS OF PROPOSED ELECTRIC SERVICE.

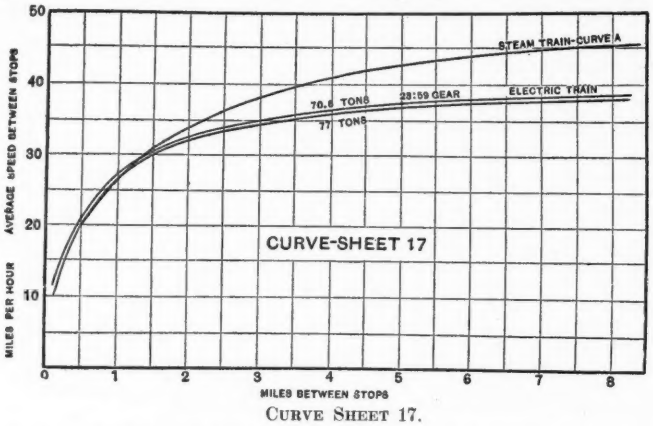
Obviously, to make the same time, the speed characteristics of the electric equipment selected for this service must be such that the schedule can be maintained with similar speed reserve, unless the limiting conditions are removed. Some of these conditions are being removed and others probably will be. Elimination of grade crossings at roads and junction points, handling of baggage and express matter by special trains, improvement of yard facilities, etc., will make it possible to operate trains at speeds closer to the limit of the equipment. On the other hand, as the population along the road increases the tendency will be to increase the number of stops with as little increase as possible in the running time; therefore, it was decided not to make any material allowance for improved conditions in the initial service. The probability of such improvement, however, suggests another precaution to be taken in the selection of equipment; namely, the provision of a suitable reserve in capacity of motors to carry the greater loads which will result from running at speeds closer to the limit.

On curve sheet No. 15 are time-speed curves of a three-car electric train with two motor cars and one trailer, with standing load in the cars, which curves may be compared with the corresponding curve of the steam train on the same curve sheet. It will be noted that the electric equipment with the lower gear ratio has a maximum speed on straight level track of approximately forty-five miles per hour, and with the higher gear ratio, thirty-nine miles per hour; whereas the limit of the steam train on the level is fifty-two miles per hour. For a run of one mile or less between stops, however, the electric train with either gear ratio makes better time than the steam train.

For a 1.5-mile run the electric train with higher gear ratio falls behind the steam train, and at slightly over two miles the electric train with the lower gear ratio falls behind.

The comparative speeds of these trains are still better illustrated on the speed-limit curves of curve sheet No. 16. The general average length of run between stops for the suburban service is about one and two-thirds miles. It is evident from the speed-limit curves on curve sheet 16 that a three-car electric train with two motor cars and gear ratio 23:59 will average slightly better as to speed than the three-car steam train, but that the same equipment with higher gear ratio falls considerably below the speed-limit of the steam train. From this exhibit it is obvious that schedule requirements indicate that no gear ratio lower than 23:59 should be adopted.

It is, also, evident from these speed-limit curves that if 23:59 is the lowest gear ratio practicable as determined by the limitations, the three-car train unit will have to be made up of two motor cars and one trailer, in order that the requisite speeds may be reached. The weight per motor for this equipment is 30.3 tons, which on this basis of speed requirements is obviously close to the limit. To determine what equipment will be necessary for a two-car train, the speed-limit curves of curve sheet 17 have been prepared. In this case the two-car train is made up of one motor car and one trailer. It will be noted that such an electric train, with standing load, falls below the speed-limit of the steam train at slightly over one mile between stops.



CURVE SHEET 17.

Speed Limit Curves for Motor Car and Trailer—Compared with steam train.
Electric train weighs 70.6 tons, seated load.
Electric train weighs 77 tons, standing load.
Steam train based on curve A for acceleration.

As regards speed requirements, therefore, the two-car train with motor car and trailer has not sufficient motor capacity, and except in cases where speed limitations are slight, two-car trains will have to be made up of two motor cars in order to make the schedule. On this curve sheet, No. 17, the corresponding curve for train with seated load has been plotted to indicate the difference in schedule speed possible during the light traffic hours of the day, as compared with the hour of heavy load morning and evening. It will be noted that in the case of heavy equipment of this character the changes in weight of live load do not materially affect the speed characteristics of the equipment.

TABLE VI.

Data for Suburban Runs, L. I. R. R., Omitting Runs Where Number of Stops Is Same as Herein, but Time at Stops Is Less.

Run.	Distance miles.	Time minutes.	Train sheet schedule speed entire run.	Intermediate No. of stops per trip.	Time out for stops.	Average Length of Run miles.	Time of average Run minutes.	A. Average speed between stops miles pr hr	B. Limit av. speed best steam train miles pr hr	Ratio of A. B steam.	C. Limit average speed electric train 23:59 gear ratio.	Ratio A C Electric.
Long Island City. Port Washington.	18.18	41.5 43.0	26.3 25.4	7 8	4.5 5.0	2.27 2.02	4.62 4.22	29.5 28.7	36.0 34.0	81.9 84.4	35.5 34.0	83.2 84.5
Long Island City. Whitestone Landing.	11.75	31.0	22 8	7	3.5	1.47	3.44	25.6	30.8	83.2	31.8	80.5
Long Island City. Rockaway Park.	16 3	39.25 39.0 40.0 41.0 43.0 43.75 47.0	24.9 25.1 24.4 23.8 22.8 22.3 20 8	5 6 7 8 10 11 14	2.5 2.75 3.5 4.25 6.0 4.5 5.5	2.72 2.33 2.04 1.81 1.48 1.36 1.09	6.12 5.18 4.57 4.08 3.55 3.27 2.76	26.7 27.0 26.8 26.6 25.0 25.0 23.7	37.5 36.0 34.0 33.0 30.8 30.0 27.0	71.2 75.0 78.8 78.8 81.2 83.3 88.0	36.5 35.5 34.0 33.5 31.8 31.0 29.0	73.2 76.1 78.8 79.5 78.7 80.7 81.8
Long Island City Valley Stream.	22.97	59.5	23 1	11	7.5	1.91	4.33	26.4	33.7	78.4	33.7	78.3
Long Island City. Manhattan Beach.	16.1	37.0 38.0 40.0 44.0	26.1 25.4 24.2 22.0	3 4 5 11	3.0 2.5 3.75 6.5	4.03 3.22 2.66 1.34	8.5 7.1 5.87 3.12	28.5 27.2 27.4 25.8	41.0 39.0 37.5 29.8	69.5 69.8 73.2 86.5	39.0 37.5 36.5 31.3	73.0 72.6 75.0 82.5
Flatbush. Rockaway Park.	15.88	39.5 44.75 45.5 47.0 48.0	24.5 21.5 20.9 20.2 19.8	7 11 12 15 16	4.0 5.0 5.75 6.5 6.75	1.98 1.32 1.22 0.99 0.93	4.56 3.31 3.06 2.53 2.43	26.0 23.9 23.9 23.5 23.0	34.0 29.5 28.5 26.5 26.0	76.5 81.2 84.0 88.6 88.5	34.0 31.0 30.0 28.5 28.0	76.5 77.2 79.6 82.5 82.2
Flatbush. Jamaica.	9.63	19.0 23.0	30.4 25.1	1 5	1.0 3.0	4.81 1.61	9.0 3.33	32.0 29.0	42.5 31.5	75 3 92.1	40.0 32.5	80.0 89.2
Flatbush. Valley Stream.	22.55	60.5	22.4	13	9.0	1.61	3.68	26.1	31.8	82.0	32.0	82.4

Attention was called to the column of table 6 which shows the ratio between the average speed of steam train between stops on different runs according to schedule, and the speed-limit possible with the best steam train in each case. Another column of this table gives the ratio of average speed to the speed-limit of the three-car electric train for the same runs. It will be noted that the reserve speed in the electrical equipment corresponds closely with the reserve in the steam equipment throughout the list. It, therefore, seems evident that this three-car train unit fulfils the requirements laid down as to speed, and can be depended upon to make the required schedule with standing load in the cars, allowing for all the delays contemplated in the present schedule for steam equipment.

It is obvious that trains made up into combinations of motor cars and trailers that give less weight per motor will be able to make better speeds than indicated for this three-car train. Furthermore, as the number of cars per train increases, the relative effect of head resistance decreases. For these longer trains it is, therefore, possible that a greater proportion of trailer cars may be used in some instances without reducing the speed-limit to such an extent as to prevent the train from making schedule time.

It is not the purpose of this paper to follow out all the technical processes by which final conclusions were deduced as to size and characteristics of motor equipments for the project referred to. Sufficient illustrations have been given to show:

First, that a study of the operating conditions of even a complex project quickly narrows the selection of motors down to one or two sizes, and that these conditions also largely determine the speed characteristics of the equipment; secondly, theoretical methods are now developed to a point of sufficient accuracy to be considered reliable for purposes of selecting equipment; thirdly, short methods may be used with discrimination, at least for preliminary determinations.

With reference to the use of short methods, a remark may be made in closing regarding the advantage to be gained by deriving a set of general formulas, applicable to all sizes of motors. On first consideration, such a problem as herein described makes such data seem almost indispensable. When we find that the only one of two sizes of motor need be considered, however, the advantage of so general a method becomes less apparent. On the other hand, with a little ingenuity, graphical or mechanical methods may be devised for plotting characteristic curves, which make it possible to determine the values of speed, current, etc., throughout a complete run with surprising rapidity. At the present state of development, therefore, it appears that the most satisfactory results may be obtained by employing the characteristics of a specific equipment rather than by spending time in deriving a set of hypothetical characteristics in which many variables are neglected.

Electrical Notes from Europe.

By Our Special Correspondent.

THE aerial telegraphy station of Porquerolles, on the coast of France, has recently been opened for commercial use. This station is under control of the government. Messages can now be exchanged between the station and the vessels of the different European lines which pass near this point, and thus communication can be made with the French coast, Algeria, Corsica and Tunisia. A decree to this effect was passed on November 17 and the tariff and regulations which were previously covered by the act of September 28, 1904, will be applied to the messages transmitted by the Porquerolles station. The principal points of this decree are as follows: the "radiotelegrams" will pay a tax of 0.75 franc (fifteen cents) per word in addition to the tariff which is due for the transmission over the land lines between the aerial telegraphy station and the sending or receiving office. The sum of these two rates will be collected from the sender of the message in the case of telegrams sent to vessels at sea, and from the receiver of the telegram in the contrary case. The messages are to bear the word "radiotelegramme," which is placed before the address. In the case of messages to be sent to a vessel, the address of the telegram must contain the name or official number of the ship and its nationality. The "radiotelegrams" are to be drawn up according to the rules which now exist for the interior messages.

The new electric mail vans which the post office department of Paris has had built for running through the city between the central and branch offices have been put in service and the authorities are well satisfied with the result. The cars carry a larger quantity of mail matter than the horse vans and run much faster, so that the hours of distributing and collecting the mail can be better arranged. The new system is of special advantage for reaching the outlying posts of the city. The speed within the city is about fifteen miles an hour, which exceeds the contract speed considerably. At present the postal service uses 600 horses. The fifteen automobiles which are now running will suppress forty horses to commence with, as they replace twenty of the old cars out of the 125 which are now used. The authorities think that the new cars will give an economy in both time and money, since the cost of keeping the horses is excessive.

An electric railroad of some importance has been lately constructed in Austro-Hungary. It runs from Tabor to Bechyne and covers a total length of twenty-four kilometres. The road is double track, standard gauge. Along its course is a bridge 174 metres long, over the valley of Luznice. The road has five main stations and six secondary stations. The trains, which travel at a speed of thirty kilometres an hour, are made up of two or three cars and carry passengers and freight. The three-wire system is used here, with a rail return for the third wire. The pressure between the outer wires is 1,400 volts. The line is supplied with current from a main station which is located at Tabor, near the end of the road. This plant, which also delivers current for the city of Tabor, is equipped with three Tischbein boilers, each having eighty square metres heating surface, combined with superheaters. There are four steam engines, of which two are used for the railroad and two for the city lighting. The engines are of the vertical compound type and run at 200 revolutions per minute, giving 120 horse-power. The generators are belt-driven. The station contains a battery of 700 Tudor cells which are run in parallel on the railway circuit. The motor cars have a motor on each of the four axles. The motors can be connected in series or parallel, and are built for thirty horse-power and take forty amperes at 650 volts, and make 550 revolutions per minute at the normal speed. The motors are of the four-pole type with a reduction gearing of fifteen to seventy-five. Each motor weighs about one ton, including the gearing. The road is now running very successfully. It is operated by the Krizik Company, of Prague.

A new lamp with a filament of tantalum has been recently brought out by the Siemens & Halske Company and it is stated that it will soon be put on the market. A considerable economy over the carbon filament is claimed for the new lamp. It uses tantalum or an alloy of this metal with another of the same group, such as vanadium or niobium. One point which is claimed for the new lamp is the non-blackening of the bulb, owing to a special method of treating the filament. The blackening occurs not only with carbon, but also with tantalum when used alone and with the osmium filament, owing to a deposit of metal which is projected from the filament. But in the present case the blackening is avoided by first removing the layer of oxide which remains on the filament. This oxide seems to be due to the process of drawing the filament, and after it is removed no blackening of the bulb is produced.

Among the large electrochemical plants which are used for producing chlorate of potash is the St. Michel works, which is located in the Alpine region on the river Arc. Current is supplied by a large hydro-electric station. The water is taken at a point about two miles above the plant, and a head of water of nearly 300 feet is obtained. The penstock is of sheet steel, 1.20 metres in diameter. The electrical outfit is furnished by the Compagnie de L'Industrie Electrique, of Geneva. It partly consists of twelve generators of 160 horse-power each, coupled to Brenier-Neyret turbines. These machines deliver a current of 500 amperes at 200 volts. The remaining groups consist of four generators of 450 horse-power each, operated by turbines. The latter are furnished by A. and H. Bouvier, of Grenoble. The generators give a current of 1,500 amperes at 200 volts. Another large plant for chlorate of potash is that of Cheddes, which is situated in the Haute Savoie region at the entrance of the Chamonix valley. The Arve river, which descends from Mt. Blanc, furnishes the power. A canal leads from the dam to a penstock of 1.40 metres diameter. The latter is 400 metres long, while the dam is located 1,700 metres above the station. Four direct-coupled turbine groups are used here. The generators, of the same type as above, run at 250 revolutions per minute and give a current of 800 amperes at 700 volts, or 560 kilowatts each. The total output of the plant is 3,200 horse-power. The dynamos are driven by Brenier-Neyret turbines.

A new alloy of aluminum which is claimed to have special qualities has been produced in Germany. It is known as zimalium. The alloy is formed by adding small quantities of manganese and zinc

to aluminum in fusion. It is harder than pure aluminum and takes the tool better. A sheet of the metal shows a traction resistance of twenty-five to thirty-five kilos per square millimetre, which is double that of aluminum. The wire has a resistance of thirty to thirty-seven kilos per square millimetre and an elongation of ten per cent. In some respects it acts like brass wire. The cast metal is easily filed, forged and drilled. The alloy has a lower conductivity than the pure metal, but its price is ten to twelve per cent less.

A new electric railroad is now running in the Gruyère district of Switzerland. It has three lines with a total length of fifty kilometres. The line uses the 750-volt direct-current system and is equipped by the Alioth Company, of Bale. The road is standard gauge and uses Vignole rails. The rolling stock comprises ten motor cars of two different types. The first type of car is equipped with four motors of thirty-five horse-power, which make 550 revolutions per minute. There are eight of these cars, while the remaining two are of heavier build and use four eighty-horse-power motors which run at 480 revolutions. The trains are made up of passenger cars—in a forty-seven-ton train running at twenty kilometres an hour, or in a 130-ton train which makes seventeen kilometres. A sixty-ton freight train is also used, which runs at a slow speed. To supply the current for the road, a station has been erected at Montbrun which can be connected with a second station located at Hauterive. Each of these plants has a capacity of 10,000 horse-power. The main lines run to a number of substations which lower the voltage for the road. Three of the substations contain two rotary groups of ninety kilowatts each, while the other two stations have two 170-kilowatt groups. In the substations the 8,000 volts of the line is lowered to 500 volts and then converted to 750 or 1,000 volts, direct current. A battery of accumulators is run in parallel on the line. Current is taken by trolley from a nine-millimetre wire which is supported on wooden poles.

Two new electric cranes have been installed on the admiralty pier at Dover. They are used for handling the baggage between the trains and the Calais steamers. Each of the cranes carries a four-ton load. The electric outfit has been supplied by Siemens Brothers, of London. There are two series motors for each crane, one motor for lifting the load and the second for carrying out the other three movements, namely, pivoting about the centre, side displacement and change of inclination of the crane. One of the features is the type of Universal controller which is used. The lifting and the displacement are operated by a single lever. The vertical movement of the lever controls the lifting, and the horizontal movement the other operations, so that the two motors are operated simultaneously from the same lever. The brakes are worked by an electromagnetic device. The controller is provided with a magnetic blow-out. The motors are specially designed for the purpose, and are of the four-pole type, giving forty horse-power. The crane lifts the maximum load at the rate of thirty-six metres per second, and makes a complete revolution in forty seconds. Current is supplied from the Dover station at 500 volts.

Among the mining installations which are now successfully working may be mentioned the plant which the Schuckert Company has placed in the Vereinsglück mine, near Zwickau. At the surface is the station building, which contains two 700-horse-power vertical engines direct-coupled to three-phase alternators. The latter machines give 475 kilowatts at 2,100 volts. The exciters are driven by non-synchronous motors. In the mine are two pumping sets, each of which consists of a Bergmann pump coupled to a three-phase motor of 220 horse-power. The motors take 2,000 volts and work at 180 revolutions per minute. They have a capacity of 220 horse-power. A substation in the mine is used to convert the alternating current to 500 volts direct current. The latter current is used to supply a number of motors which are used throughout the mine and also for the lighting current in the mine and at the surface.

The power transmission line from Gromo to Nembro, Italy, uses one of the highest voltages in Europe, as it is now working at 40,000 volts. The plant was installed in order to supply current for the extensive cotton works of the Crespi Company, which are located at Nembro. The distance is thirty-two kilometres. The hydraulic plant at Gromo is laid out on the three-phase system. The Brown-Boveri firm supplied the equipment. The station now has three groups of 1,000 horse-power each, together with the exciter sets. One peculiarity of this plant is that each machine is connected directly to an 850-kilowatt transformer, and thus the turbine, dynamo and transformer form a single unit. The same system is in use at the Como 20,000-volt plant. The transformer receives 4,000 volts from the alternator in the present case and raises it to 40,000 volts. The current is then sent to the switchboard bars so that a parallel coupling can be used. The alternators work at 500 revolutions per minute and fifty cycles. The twelve-pole field revolves inside the armature. The total weight of the machine is 13.5 tons. The transformers have an oil bath and are water-cooled. At the other end of the line is a set of transformers which reduces the voltage to 500 volts for the motors. They have a capacity of 500 kilowatts and are also water-cooled.

The forts of St. Maurice, near Lake Leman, are now provided with an electric equipment which serves for the lighting as well as for operating the different arc projectors. The Thury system of apparatus is used here. The central station which has been recently installed is intended to work in parallel with a second plant or to be used as a reserve for the latter, if need be. The former station contains three direct-coupled units. These consist of petrol motors of the Deutz pattern coupled to seventy-five-kilowatt generators. The latter machines deliver 200 amperes at 125 volts and run at a comparatively slow speed, 250 revolutions per minute. The switchboard which serves for the three generators and for the lighting and the projector circuits comprises seven white marble panels, of which three are used for the dynamos, one for the three projector circuits, two for the six lighting mains and one for connecting the plant with the second station. Besides the usual appliances, the machine panels contain a starting device for the gas engines, so that the latter can be started up or stopped from the switchboard. The projector panels contain a switch for the motor which operates the movements of the projectors.

The Valtelline electric railroad which uses a 3,000-volt three-phase system at fifteen cycles is soon to try the Finzi monophase system. The trial car will have four monophase motors of 100 horse-power. The motors will work at 200 or 400 volts. The car is to have a controller at each end, but will not use a rheostat. It will take 3,000 volts directly from the overhead line by the system of trolley which is now employed. Each of the four motors will drive an axle of the car by reduction gearing. The motor car is to

draw a train of 100 tons and it is expected to run it at fifty miles an hour.

The main generating station of the city of Hanover, Germany, now contains two alternator groups of 1,000 horse-power each. Steam is supplied from four Steinmüller boilers. The main dynamo room contains the direct-coupled groups. The engines, of 1,600 horse-power each, are furnished by the Hanover Machine Company. They operate at eighty-three revolutions per minute. The alternators deliver 5,500 volts directly, at fifty cycles. Direct current is supplied by converter groups, consisting of a high-tension synchronous motor coupled to an eighty-kilowatt generator. A battery of accumulators is run in parallel with the latter machines. Near the main plant is a substation containing two rotary groups, one of 400 and a second of 800 kilowatts. Most of the electrical outfit has been furnished by the Schuckert Company.

It is reported that the Swedish government is to make a series of official tests relating to electric traction on the main railroads. To this end it proposes to build a special track for running experimental trains, and will use a system of alternating-current motors or locomotives. Current will be supplied from a station especially erected for the purpose. The following details are given as to the electric equipment. Two types of locomotive will be tried. The first is to be furnished by the Westinghouse Electric Company, and will have two axles operated by series motors. The second form of locomotive is to be built by the Siemens-Schuckert firm, and has three axles. Transformers will be mounted upon the locomotives for lowering the main voltage. In addition to this, the Allegemeine Company is to furnish a passenger train made up of four cars. The latter will each have four axles and will be equipped with motors of the Winter-Eichberg type. The motors are to operate at 6,000 volts and twenty-five cycles.

C. L. DURAND.

Paris, November 26.

Journal of the British Fire Prevention Committee.

The Journal of the British Fire Prevention Committee, containing a record of the Baltimore conflagration last February, has been issued. This is one of the best reports on the subject which has been seen. It contains a summary by Edwin O. Sachs; the report of the special committee of the National Fire Protection Association of the United States; the report to the Chief of Engineers of the United States Army; the report of the insurance engineering experiment station, Boston, and the conclusions of the special committee of the National Fire Protection Association of the United States. There are sixty-seven illustrations, which are photographs taken during the progress of, and after the fire.

American Association for the Advancement of Science.

The fifty-fourth annual meeting of the American Association for the Advancement of Science will be held in Philadelphia, Pa., December 27 to December 31, 1904. There will also be meetings of several affiliated societies during the same period.

The meetings will be held in the buildings of the University of Pennsylvania. A meeting of the executive committee of the council of the American Association for the Advancement of Science will be held at the office of the permanent secretary, in the Hotel Walton, Broad and Locust streets, at noon on Tuesday, December 27.

The opening session of the association will be held at ten o'clock A. M., Wednesday, December 28, in the chapel, College Hall, University of Pennsylvania.

All matters relating to the local arrangements, hotel and boarding-house accommodations are referred to the secretary of the local committee, Professor Philip P. Calvert, University of Pennsylvania, Philadelphia, Pa.

All information relating to the presentation of papers can be had by addressing the secretaries of the respective sections. The titles and abstracts of papers should be sent promptly to the secretaries, or to the permanent secretary, L. O. Howard, Cosmos Club, Washington, D. C.

Electricity in Farm Work.

A number of farmers of Kane County, Ill., have been experimenting with electricity, and have demonstrated that they can make the electric motor take the place of human and horse labor on their farms in many instances. The following figures, compiled by Mr. Lueck, manager of one of the richest farm tracts in the county, show the comparative cost of farming by electricity and by animal labor:

Cost of installation of electric motor	$500
Cost of power furnished per year, about	30
Cost of repairs, etc., one year	10
	$540

Cost of one farm hand, wages one year, at $25 a month	$300
Cost of board and lodging same, one year at fifty cents per day	185
Cost of team of horses at $125 each	250
Cost of feed for same, five-acre land production for one year	200
Cost of shoeing, veterinary, repairs to harness, etc., one year	25
	$960

Cost of operation by animal labor	$960
Cost of operation by electricity	540
	$420

It was found that one fifteen-horse-power motor does about the same work as one man and two draught horses. The county in which these experiments were made is about thirty miles long and eighteen miles wide.

BOOK REVIEWS.

"Wire and Wireless Telegraphy." Edmund B. Moore. Springfield, Mass. Reporter Publishing Company. Paper. 38 pages. 5½ by 7¾ inches. Supplied by the ELECTRICAL REVIEW at 50 cents.

This small pamphlet is the ambitious attempt of a boy of sixteen. As its title indicates, it deals with the electric telegraph.

"Elements of Mechanism." Peter Schwamb and Allyne L. Merrill. New York. John Wiley & Sons. Cloth. 264 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $3.

This is a compilation of notes which were written by Mr. Schwamb for instruction in the study of mechanism at the Massachusetts Institute of Technology. The material contained in the book is not new, but is principally a compilation of the works of other authors. It is presented in a clear and concise manner, and graphical and mathematical demonstrations are given throughout the book, together with practical applications. A number of pages are given up to link work, and nearly one-third of the book is devoted to the subject of gearing.

"The Electrolysis of Water, Processes and Applications." Viktor Engelhardt, chief engineer and chemist of the Siemens & Halske Company, Limited, Vienna. Translated by Dr. Joseph W. Richards, professor of metallurgy at Lehigh University. Easton, Pa. Chemical Publishing Company. Cloth. 140 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.25.

This book, which constitutes volume i of a series of monographs on applied electrochemistry, is a striking testimonial to the progress which has been made in electrochemical applications during recent years. While it has been known for over a century that the electric current flowing through conductive water decomposes it into oxygen and hydrogen, and almost every text-book on physics and chemistry briefly describes the experiment, it is only within the last twenty years that the operation has emerged from the laboratory to the technical stage. The industrial importance which electrolytic oxygen and hydrogen have attained in that brief time is the justification for this new work. Electrolytic methods have been found to be cheaper and otherwise more advantageous than the chemical methods for producing oxygen and hydrogen. This has been recognized much more extensively in Europe than in this country, and the book in question which is written by the chief engineer and chemist of the Siemens & Halske Company, of Vienna, deals almost exclusively with European practice. The work is technological, but is also of value to the electrochemical student as it shows the various forms of cells which may be

used advantageously in a process so apparently simple as the electrolysis of water. The historical ground is covered by brief descriptions and references. The various well-known forms of laboratory apparatus are illustrated, and detailed descriptions are given of the various more successful electrolyzers. The treatment is thoroughly practical, even to the exclusion of theoretical considerations. An especially valuable feature is that dealing with the itemized cost of the production of oxygen, hydrogen, and "detonating gas." The form of apparatus which is most satisfactory for industrial purposes depends upon various factors, including economy of power, purity of product desired, freedom from liability of explosion, etc., and the choice of apparatus depends upon which of these factors is the most important for the case in hand. The various kinds of diaphragms used for separating the gases are discussed; and in addition to the electrical features, descriptions are given of the auxiliary apparatus, including piping, safety devices, purifiers, gasometers and compressors. A section is devoted to the uses which are being found for oxygen and hydrogen, such as high temperature working, lighting, blasting, soldering, lead burning, and for balloons, and the fact that there is a field for the extensive use of oxygen in combustion furnaces, for oxidation in the Bessemer converter, glass furnaces, technical organic and inorganic processes, the production of ozone, and for medical uses, is pointed out. The work of translating has been most admirably done by Dr. Richards and the book is in a form most serviceable to the American reader. While the metric system of measurement has been adhered to, the items of cost are expressed in terms of our monetary system.

"The Electric Furnace." Henri Moissan. Translated from the French by Victor Lenher, Ph. D., University of Wisconsin. Easton, Pa. The Chemical Publishing Company. Cloth. 305 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $3.

The earliest work done with the high temperatures that may be reached by the use of electricity was that of Despretz, who in 1849 described various experiments on the fusion and volatilization of bodies, in which he used a battery of 600 Bunsen cells. These early experiments are of considerable interest, adumbrating as they do the modern developments which have led to the "chemistry of high temperatures," and to the important industries depending on the use of the electric furnace. But above all others the name of Henri Moissan will be associated with the electric furnace, because of the astonishing amount of work he did some years ago with this apparatus, and finally published in collected form in "Le Four Électrique." This book was published in Paris in 1897, but in spite of its importance no English translation appeared until that of Dr. Lehner. The first chapter of "The Electric Furnace" is devoted to a description of the furnaces used in the numerous experiments which follow. These furnaces are no doubt eminently satisfactory for much laboratory work where the object in view is to obtain results as quickly and simply as possible. But arc furnaces have some serious disadvantages, as the regulation of temperature can not be controlled with the accuracy required for many kinds of work. We think there can be little doubt that the brilliant success attained by Moissan with his laboratory arc furnace led many experimenters to believe that the arc was the ideal form in which to use the electric current for high temperatures, and this perhaps retarded somewhat the evolution of the modern industrial forms of furnaces which seem to tend more and more toward the use of the resistance types. About one-third of the volume is devoted to a very thorough study of the various forms of carbon—amorphous, graphitic and crystalline; and culminates in a description of the artificial production of the diamond. This part of the book is of great interest, because, as Moissan points out, in spite of the immense amount of work that has been done in the chemistry of the carbon compounds, comparatively little time has been devoted by experimenters to the physical and chemical properties of the element carbon. In chapter iii we have an interesting account of the preparation of various elementary bodies in the electric furnace. Some of these, such as chromium, tungsten, silicon, etc., are now manufactured commercially in the electric furnace, or their alloys with iron are produced in that way. The industrial developments along these lines have been more marked in Europe than in America, despite the favorable conditions that exist here both as regards raw materials and power. The study of the carbides and silicides of a great number of elements is very interesting scientifically, though so far none of these has become commercially important with the exception of calcium carbide and carborundum (silicon carbide). It is somewhat disappointing that so far the remarkable property possessed by several of these carbides of decomposing in water, with the generation of various hydrocarbons, has not led to any important developments, with the exception of the manufacture of acetylene gas. It would seem that we should find in these phenomena an excellent starting point for important developments in synthetic chemistry. Moissan gives in this book interesting data as to the results obtained by the aqueous decomposition of these carbides, and suggests that in the resulting phenomena we may find an explanation of the petroleum products found in nature. The silicides of various metals and their preparation are described, as well as borides. The boride of carbon, which Moissan describes as belonging to the same class of bodies as carborundum, is said to be the hardest substance produced in the electric furnace, with the exception of titanium carbide. Both of these bodies are said to grind diamond, although silicon carbide will not. However, Acheson has described an experiment in which he had a diamond polished, using carborundum powder. Probably the carbides of boron and titanium are harder than silicon carbide, but probably not sufficiently harder to be worthy of manufacture for that purpose. The book contains some new material on certain phosphides, silicides and arsenides. It is to be regretted that there is no index to the volume, for the value of a book of this kind is certainly lessened by its absence. The English of the translation is poor, adhering too literally to the French and sometimes making the meaning difficult to grasp. The book will undoubtedly be found useful by all who are engaged in experimental work with the electric furnace.

Traffic in the Subway During the First Month of Operation.

At seven o'clock on the evening of November 25 the New York subway had completed twenty-nine days of operation. In that time 5,838,235 passengers were carried, not counting policemen and firemen, who travel free, or the people who travel on passes. These figures do not include the traffic of the Lenox Avenue branch, which had been running for a few days before that time. A trifle over one-fifth of the passengers entered the trains at the Brooklyn Bridge, the total number of passengers from this station being 1,185,863. The Fourteenth Street station contributed 428,318, and the Grand Central station 476,670. The average daily traffic, not including the Lenox Avenue branch, was 201,318. The daily average receipts were $10,065.90.

SOME DIFFICULTIES IN GETTING ON.[1]

BY JAMES SWINBURNE.

The first difficulty is to know what equipment is necessary, and how to get it. That is to say, to know what ought to have been learned, and how to make up any deficiencies. At once each of us is confronted with the question, "what is going to be my work?" I say "us," because the difficulty in many cases is permanent; one never knows what he will be called upon to tackle in the future. The difficulty is much greater, however, in the case of a young man, because he has probably the vaguest idea of what his life's work will be, and that idea time will show to be quite wrong. Ladies have at different times told me that so-and-so, the new Archbishop of Canterbury, said as a boy, he intended to be an archbishop, and this shows wonderful strength of character, and all that sort of thing. But probably every curate intended to be an archbishop, as there is only one career open, and one top. The lesser peak at York is of the same character. But in engineering it is quite impossible for any one to start out with a definite career before him. He is like a particular particle setting out across a containing-vessel of gas. He can not career straight across. He is buffeted about and frequently goes in quite the wrong direction. If he is charged and in a field he will zig-zag across in front of most of his fellows. A man who has made a specialty of electric waves gets his first appointment as inspector of meters to an electric light company, and so on. A well-known engineer remarked to me the other day that he found his knowledge of differential equations, and his experience in the correct analysis of the rare earths was of little use in putting in sewage plant. Yet he had made lots of use both of his mathematical and chemical analysis in his time. Probably each man should have a general knowledge of applied physics and chemistry and mathematics, and a special knowledge of one or two subjects. The special knowledge may never come in useful; but the chances are that in the blind stumblings we call our careers a specialty may be very valuable. If you glance round at the work of some of our big men you will be surprised to see how many have made their reputation by doing one small thing, but doing it well. If a man gets to the front in one narrow subject the world credits him with knowledge of all the rest. It is, however, even easier to acquire a large general knowledge than an advanced special knowledge of one narrow subject. The specialty must not be too narrow either.

One of the great difficulties is to keep knowledge in a polished state ready for immediate use. In practice it may have to lie idle for long periods and then be wanted very much on short notice. This fact is overlooked by people who suffer from the modern craze for writing about technical education. For instance, we are told that all engineers ought to have the calculus at their finger ends, and so on; but it is forgotten that though an engineer ought to be well up in mathematics, he only makes a calculation requiring higher mathematics once in several years, perhaps; and it is impossible for him to keep his mathematics in working order down to minute details. All he can do is to keep general principles in his mind. Probably the one thing to do is to treat knowledge as a huge district into which one's life is long enough to make some very little roads. From each main road there are branch roads, and from each branch road little paths, and so on to an infinite extent. Many places can be reached by several paths. Each road or path gets obliterated by weeds if it is not constantly trodden. Life is too short to make many roads or paths, and very much too short to keep many of them in order by constant use. The best thing then is to keep one or two main roads clear, and remember where the branch roads and paths are, and go over them again when needed. To go back to plain speaking, the great thing is to master a certain number of broad fundamental principles which give a starting point for refreshing old knowledge or acquiring new. For instance, in physics, the law of conservation of energy and all that follows from it; the principles of the kinetic theory of gases; the ideas of lines or tubes of force; the principle of the interlinked circuits; the principle of the growth of entropy in all thermodynamic changes.

Science, for which no use has been found, or which is not applied, is called "pure science," whereas it is really the raw material, and should be called "raw" or "crude science." There is an assumption of superiority in the term "pure "science," and generally the term "science" is appropriated by workers in raw science in much the same way as the term "workingman" is appropriated to the exclusion of brain workers. There is supposed to be something noble and superior about "raw science," and its study is treated as the unselfish devotion to the interests of man, which is obviously entirely the wrong way round. The so-called "scientific man" thinks that engineers and manufacturers are ignorant and unscientific, and that their practical knowledge is of no account; and that the cure for all industrial evils is more technical education, more universities and more power to the science masters. Though there are in existence a few practical science teachers they are rare. Perhaps no one would be more surprised than the average science master if you told him he was unpractical, and was, by his attitude and example, hindering science. He does not mean to. He is as keen as possible to do just the reverse, and is generally exceedingly anxious for the spread of science or technology; but, unfortunately, he has got a wholly wrong view of the relations of science and business. There is no more baneful influence on the technical advancement of this country than the Royal Society ideal in science.

It is often said that the pursuit of knowledge has a nobility of its own. But what knowledge? No knowledge is worth obtaining for its own or any other sake, unless it is or will probably be useful to man.

I would earnestly urge any of my hearers who has the idea that there is something noble and superior about "raw science," or who thinks little of business men, to get rid of all such notions if he hopes ever to get on. If you look round the electrical industry, or round the industries generally, who are at the top? Always the business man. The men at the head of large industries generally know very little science. A man may run a large electrical industry with the most vague ideas as to the true relation of the electrostatic and electromagnetic systems of units; in fact, he may think power, force and energy are very much the same kind of thing if looked at in a broad commonsense way without any scientific prejudice. If he wants good technologists he employs them. If he wants practical men who can take commercial responsibility he pays good salaries, if he wants men full of book knowledge he pays low salaries, but he does not generally want them. Raw scientists, to coin a horrible word for a most estimable class, tell him he knows nothing about science, and therefore does not know how to run a scientific business, and tell him to subscribe to universities, which are so inefficiently worked that they have to beg, like hospitals, and to employ young men from the technical colleges.

[1] Address delivered to the students of the British Institution of Engineers. Abridged.

He either takes no notice or he gets annoyed at their superior attitude, and discharges a couple of scientific men and puts their saved wages toward the salary of a new practical chauffeur, and enjoys himself. Yet the science teacher looks down with contempt on the engineer as an ignorant rule-of-thumb inferior person, and an engineer in his turn looks down on the business man as a money-grubbing person with no brains and no lofty ideals. But this is all topsy-turvy. The business man at the top, the practical engineer in the middle, and the unpractical engineer or the raw scientist at the bottom. The business man may have no knowledge of the ways of nature, but he has a knowledge of the ways of man, a knowledge which is infinitely more difficult to acquire and infinitely more difficult to employ well. His brain may be different from that of the scientific man; but there is no reason to suppose that it is less. Its convolutions may be different, but the probability is that they are even more complex than those of the scientific man.

A man's value to the world at large may generally be roughly estimated by the income he earns. Where position is earned at the same time, the money income is in proportion less for a given usefulness; but taking such disturbing elements into account, the rule is broadly true. The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant. Just as the raw scientist looks down on the engineer, and the engineer looks down on the business man, so the business man has a contempt for the engineer; and the engineer in his turn looks on the raw scientist as an unpractical crank. So much is this the case that the business man will not trust the engineer more that he can help. He assumes that if you know anything about anything you can not possibly be a business man.

If you examine the large industries you will, as I say, find the commercial or business man with little or no technical knowledge at the top of the tree. If you confine your attention to engineers, you will find the engineers who make the biggest incomes and occupy the most important and responsible positions are those who have most business and practical knowledge. Our leading consulting engineers do not spend a large portion of their lives plotting curves, counting electrons, or even making anything more than arithmetical calculations. They spend their time dealing with large questions on purely commercial lines; and, as a rule, the bigger the engineer the more he knows about practice and business, and the less he knows about text-book science. I do not for a moment mean to say that text-book science is not of priceless value; of course it is; and the more scientific knowledge you or I, or still more, the leading engineers have, the better; but most of us suffer from too little common sense in proportion to our scientific knowledge.

The engineers occupying smaller positions, assuming the same age in both cases, are not necessarily deficient in technical knowledge; but they are generally wanting in business attainment and less able to take responsible positions. It is often said that to be a good master you must have been a good servant; but a good servant does not necessarily make a good master, generally the reverse. There is a wide distinction between the man who can earn a few hundreds a year and the man who earns as many thousands. It is a very curious thing that there is hardly anything between. One type of man will either earn his few hundreds a year all his life, remaining permanently an assistant, or he will undertake responsible work and get into fair figures. The engineer who is worth £750 a year seems hardly to exist, except for a short time on his way from one class to another. This is what is meant by the saying that there is plenty of room at the top of the ladder. It is not that the men who remain as assistants permanently are ignorant of science, quite the reverse. The business man can rent a profound mathematician for a very few pounds a week if he wants him; but he probably does not. The real point is that the assistant is wanting in business knowledge or in push. If he is wanting in ambition, or lazy, nothing I can say is to the point; but he may be suffering from a false notion of the relative values of raw science, technology and business knowledge.

In the charter of the Institution of Civil Engineers the engineer is defined as "directing the great source of power in nature for the use and convenience of man." With all respect to this august body, and its often quoted definition, I would humbly suggest that it is bad. It is really the definition of a scientific man. It is incomplete as applied to an engineer, because it does not take into account the sordid element of price. An American definition is much better—"an engineer is a man who can do for one dollar what any fool can do for two." This is not poetical, and is useless for oratorical purposes; but it is right. It is no use being able to design most complicated alternating-current machinery, or being able to explain it with the help of a wilderness of clock faces and several issues of the technical journals, unless the machine, when made, is cheaper than its rivals. Every design, every engineering manufacture, and every piece of engineering is only a question of price. It is unpleasant, perhaps, but it is a hard fact, and we have got to face it. If one of us does £150 worth of work a year, and earns £100, he is efficient; if he only does £90 worth, he is an inefficient machine, and will come to grief. He is like a ninety-kilowatt alternator which takes 100 kilowatts to excite, though the analogy is not close. If he does £15,000 worth of work and gets £10,000, he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realized. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero; his consumption being equal to his output. The man who does £15,000 worth of work and gets £10,000 consumes two-thirds of the work himself; so his efficiency is only thirty-three per cent; which is very high, even for an engineer.

We see, then, that the business man is the master; the engineer is his good slave; and the raw scientist is not good enough even to be the slave of the engineer; he has no market value at all, except as a teacher of more raw science. The raw scientist will remain at the bottom of the tree until he gets rid of the professional cant which pretends that raw science is pure, or nobler and superior to science as a whole; and the engineer will remain in the middle position as long as he takes the middle view and considers engineering as something superior to money considerations, and as long as he looks down on business and commercial methods.

Views like these put forward in addresses do not alter the world at large, and they are not expected to do so. They are put strongly to warn you, who are young, and therefore inclined to be enthusiastic against one of the greatest difficulties in getting on; that is to say, a poetic idea that there is something degrading or deteriorating in taking a money view of everything. You may say, "we take higher views of life than that: there is something better for us in our careers than money grubbing." So there is; I heartily agree with you; and when you have grubbed some money and are

at liberty to attend to higher things, I would like to be allowed to join you.

It is cant to profess contempt for money. The poet professes to work for fame, and so do the musician, the artist, the philosopher, the scholar or the man of letters. They generally like money; but apart from that they are merely satisfying their proper vanity, or love of approbation, by getting ahead of their fellows. But that is all you want to get on for. Money is nothing in itself, it is only a means, and making it is merely a way of going ahead of your fellows. People who can not make money do not like it being used as a criterion, so they run it down. Every one thinks the world ought to be judged by what he can do best himself. If you want to be poets you have my sympathy, but I can not deal with you in this address. I can only ask you to eschew cant.

You may, on the other hand, ask "how are we to get business and commercial knowledge?" You may say, "you are much older than we; you were practising engineering several years before any of us were born. How did you get all your practical knowledge and become an engineer?" I can only answer, "I am only a very little bit of an engineer." I know I will never be much of an engineer. This is mainly because this practical difficulty in getting on has always been in my way. I am entirely out of sympathy with the whole of this part of my address to you. I so much dislike saying it all that I know it must be true.

I can not tell you how to be engineers, because I do not know. All I can do is to make you realize some of your wants; and if you know what you want, you are more likely to get it. One of the greatest difficulties in getting on is to find a good opening. At present, especially, times are very bad, and many big incomes have fallen to negligible quantities. The profession, or business or trade seems to be overstocked; but everybody is apt to think his own business is overrun. Most of you have probably had, or are having, very thorough college trainings. Unfortunately you will find that even good college educations are not of high market value. That is largely because technical colleges are subsidized, so that education costs the student little money. This tends to reduce its market value, however good it is in itself. You will find all about this in books on political economy. Mill deals with it, I am sure.

Then as to the different branches of the business—business is really a higher title than profession—in which are you to find openings? From the number of applications I receive from young fellows, it seems to be a common idea that consulting engineering is a good thing to begin upon. This is a curious notion. A consulting engineer is supposed to be a highly skilled engineer, with so much experience that he is an authority. I should have thought at least twenty or thirty years' experience, apart from school and college training, was necessary for a consulting engineer to be worth his salt. But there are various grades of consulting engineer; and I am entirely at a loss to know what the qualifications of the consulting electrical engineer really are. Then still less do I know what the consulting electrical engineer will be by the time you have had twenty or thirty years' experience. At present most of the large towns are electrically lighted, and have their tramways; railways will be electrified by that time, and it is probable the work will be done by their own men. Supervising contractors who are doing wiring will not be much of a profession in twenty years; and if that is consulting engineering, I do not think so much as twenty years' training is necessary.

In manufacturing work there is the designing of dynamos, motors, transformers, and so on. This was considered high grade work when I was a young man; and even very able men built some very queer machines in those days; and we were all pretty ignorant. But the works were smaller then, and salaries for dynamo designing were not princely. But now there is not much opening in electrical machine designing. There is some, of course, but it is not as it used to be. There are many openings to be had in central station work; and stations are growing bigger and more important every day. At present there are also many applicants for every opening. Central station work in a position of responsibility is very anxious. I do not think it is very well paid either. You will find exceedingly able engineers in most of the large town stations; and I am sorry to say their incomes are often very small for men of their technical and commercial ability. The assistants are often poorly paid, especially, I think, in municipal stations; though I do not know why this should be.

A large number of young men go in for installation work—which sounds as if they started bishops on their episcopal careers—but really means that they do what is in fact electrical plumbing, under an unnecessarily imposing name. There are a great many of them, and they seem to spend most of their time going into and out of partnership with one another, like ions, and sending notices round to that effect. At other times they go bankrupt and send no notices. The upper grades in teaching science are well paid, more especially as a position goes with an appointment, and there is time and facility for original research, which is a luxury and brings reputation. Moreover, a steady income with no expenses is a very blessed thing. But the lower grades are very poorly paid in proportion to their ability.

All this may sound rather discouraging, but I am dealing with the difficulties of getting on, and I am sure it will not discourage any one who is worth his salt. At first it is very discouraging to make very little, and the good man has little chance of showing his superiority to the common run. But he should always remember that incomes as a young man is very little criterion of real value. There are many careers in which a young man can make something almost at once; but in all cases the income increases very slowly. In such a business as engineering a man of first-rate ability may be quite unable to make enough to marry on till he is thirty, or enough to be comfortable on until he is forty. An eminent north country engineer, whose name you would all know, though he has been dead some years, said that he did all the hard work of his life for thirty shillings a week, and when he was well on in life money came rolling in of its own accord. I have reason to believe that one of our foremost engineers, now dead, never made £500 a year until he was over forty.

Though you may not like it, a hard struggle is very good for a young man who has anything in him. It gets him into the ways of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from the mere force of habit. Nearly all great men rise from almost nothing with infinite trouble in their youth. There is nothing worse for a young man than to have about £200 a year of his own. He lives comfortably and does not worry; and when he is thirty he wants to marry and finds he can not, and it is too late to begin life seriously then. If any of you have this sort of private income he had better go into partnership in installation work for a year or two, and then begin his business seriously.

I have only mentioned a few of the difficulties in getting on. I am sorry to say there are many more, which you will find out in good time.

Reviews of Current Engineering and Scientific Literature.

Modern Application of Electrically Driven Pumping Machinery.

Under the title, "Development of Dry-Dock Pumping Machinery," Joseph S. Schultz, United States Navy, describes some recent dry-dock equipments. The most modern and satisfactory of pumping plants for driving are electrically driven. An excellent example of this kind of plant is that of the United States navy yard, at New York. Here the pumping plant serves to drain two parallel dry docks, 350 feet and 625 feet long, respectively. It is located between them in a well thirty feet deep and forty-five feet in diameter. It is perfectly water-tight, and roofed over with a heavy concrete-steel construction. Within this well are three forty-two-inch, horizontal shaft, centrifugal pumps, each of 50,000 gallons capacity per minute, interconnected to each dock through motor-controlled valves. These are the primary units of the plant. There are two sixteen-inch pumps of the same type, which provide for any leakage while the docks are empty. These pumps are primed by a displacement pump driven by a ten-horse-power motor. The motive power is furnished by three 415-horse-power induction motors, direct-coupled to the shafts of the large pumps. The smaller pumps are driven by 125-horse-power motors of the same type. They are supplied with three-phase current at sixty cycles, 2,000 volts. For a dry dock, electrically driven pumps are most satisfactory, because they may be placed below the surface of the ground, leaving the entire yard room for the storage of material and for working. Although induction motors are at a disadvantage in driving centrifugal pumps, in that their speed can not be economically varied, for such installations as are here considered this defect is of little weight, because it is always desirable to empty the dock as quickly as possible, and the motors normally run at full load.—*Abstracted from the Engineering Magazine (New York), December.*

Notes on the Efficiency of Gas Turbines.

This is a theoretical study by M. Alfred Barbezet of the conditions of operation of the Armengaud-Lemale gas turbine. This turbine consists of an impulse wheel resembling the De Laval wheel. On one side is placed the combustion chamber, which consists of a bell-shaped retort lined with refractory material, terminating in an expansion nozzle. The gas and air are forced in at the end opposite to the nozzle, and are ignited by an electric arc, combustion taking place in the chamber. The products of combustion passing out through the nozzle require a certain velocity and impinge upon the blades of the turbine. The nozzle itself is water-jacketed. The speed at which the wheel revolves is such that the gas has a certain velocity when it leaves the blades. The hot gases are then passed through a steam generator, made in the form of a coiled pipe, the diameter increasing successively until it terminates in a second expansion nozzle. The steam generated in this boiler is thus directed against the turbine blades, adding to the propelling force, and at the same time cooling the blades. Complete combustion is attained in twenty per cent excess of air. A machine of this type has been operating for two years at St. Denis, Switzerland, and sufficient data have been collected to enable the process to be considered satisfactory. The thermo-dynamic efficiency approaches that of the Diesel motor, being 53.5 per cent. The total efficiency is given as eighteen per cent. The latter figure will be considerably improved with better construction, it being thought that the mechanical efficiency of the turbine will be raised to sixty per cent, and that of the air-compressor to eighty per cent. This will give a total efficiency of the machine of twenty-six per cent. With this figure, one horse-power will be given with a consumption of 220 grammes of oil.—*Translated and abstracted from L'Éclairage Électrique (Paris), November* 19.

A Model Storage Battery House.

A model storage battery house, erected by the Cleveland Electric Railway Company, is here described by Mr. H. F. Cobb. The building is one story high, fifty feet wide and 122 feet long. There is a monitor extending the entire length of the roof. The building is divided by two brick partitions into three rooms. The front is a booster room, next is a battery room containing 252 cells, while the rear is divided into a storeroom and boiler room, steam being used for heating the building. Ample ventilation and light are obtained from numerous windows in the side and end walls and in the monitor. The only wood in the building is that used for the window frames, sashes, doors and door frames, and the casing of part of the structural work of the monitor. The walls are of brick, with concrete foundations. The floors of the booster room, the boiler and storerooms are concrete, while that of the battery room is vitrified tile, set in one-half inch of sand on a cinder concrete. The battery room is divided lengthwise into three panels by two rows of seven-inch, I-beam columns extending to the roof of the monitor, which is over the centre panel and runs the entire length of the battery room. In each panel there are two rows of batteries with three-foot walls between them. The roof is a concrete-steel structure of "ferroinclave" construction. This is formed of sheet steel, crimped in a dovetail form, and laid in a manner similar to ordinary corrugated iron, cemented on both under and upper sides with a mixture of one part sand and one part Portland cement. The finished roof is one and one-half inches thick, and weighs nineteen pounds to the square foot. The upper side is covered with three plies of felt, tar and gravel. All the structural work in the battery room is wrapped with wire and covered with concrete composed of a mixture of three parts of sand and one part of Portland cement. As a secondary precaution against hair cracks in the concrete, the ceiling beams and columns were painted with glue and then with two coats of oil paint. The insurance rate allowed on this building is the lowest possible. —*Abstracted from Insurance Engineering (New York), December.*

Notes on the Metallurgy of Aluminum.

In the choice of an electrolyte for the production of aluminum, according to M. Gustave Gin, the following properties should be considered: the point of fusion should not be high; the molten mass should be fluid with a density less than that of the molten aluminum, and the electrical resistivity should be as low as possible. From a chemical point of view the compound to be electrolyzed should have a low energy of combination. With any electrode whatever the amount of aluminum produced depends only upon the quality of electricity passed through the cell. From this it follows that the consumption of energy is directly proportional to the voltage of the bath. This

voltage may be separated into two parts—that due to the resistance of the bath, and that due to polarization. Unfortunately, there is but little information covering the latter point. A number of electrolytes are examined, and the theoretical voltage required for decomposition is predetermined. For the haloids of aluminum this appears to be 3.93 volts. Experimentally, it is found to be 2.5 only. This discrepancy is thought to be due to a change in valency of the aluminum, and a formation of a double salt with sodium. Allowing for the energy set free in this way, the theoretical value of the voltage is reduced to 2.49. Assuming the electrolyte to consist of bauxite, the theoretical value of the decomposition electromotive force is found to be 2.19. That found experimentally by Le Blanc is 2.3 volts. If the electrolyte be sulphide of aluminum, the theoretical value required to cause decomposition is 1.27 volts. It is from these figures that the following energy consumptions are computed: to produce aluminum from cryolite, the energy required will be about twenty-five and one-half kilowatt-hours per kilogramme of aluminum. For bauxite the figure will be about twenty-four and one-half kilowatt-hours, and for the sulphide it will be but twenty-one and two-fifths kilowatt-hours per kilogramme of aluminum.—*Translated and abstracted from the Revue de l'Électricité (Lausanne), November 15.*

Means of Avoiding Dangers Due to Electrical Conductors.

A careful study has been made by M. Victor Kammerer of the dangers arising from the use of electrical energy. In the present section of this series the author deals particularly with means which may be adopted to diminish the danger. These may be divided into three classes: first, the general precaution to be observed in the choice of material and installation of apparatus in the station, with a view to diminishing the fire risk; second, the arrangement of this apparatus, with a view to diminishing the risk of accidents to persons; third, the precautions which must be taken in the operation, in order to avoid accidents and breakdowns. As general measures of precaution only the most reliable apparatus should be employed, and this should be erected in the most substantial manner. To diminish danger of contact from conductors, certain simple dispositions should be adopted. All bare conductors under pressure, when it is possible for strangers to approach them, should be put out of reach or protected in some manner. This rule should hold even when personal contact with the conductors themselves would not be harmful, because such conductors may become sources of danger, due to other accidents. All switches should, of course, be enclosed in boxes. For convenience, conductors may be classed as high pressure and low pressure. In the latter class are placed all alternating-current circuits, the voltage of which is not over 250, and all direct-current curcuits whose voltages are not over 500. Bare conductors carrying such feeders are tolerated only when they are commutators, rheostat contacts or other similar devices, and the attendants should be protected by providing an insulating platform in front of them. High-tension conductors should not be allowed in the generating room, unless they are entirely shut off from the operators. The enclosing cage should be locked, and responsible men only should be permitted to enter it. Distributing switchboards should have no high-voltage conductors upon their face. The rear should be enclosed, thus becoming a distributing room. The German regulations allow high-tension conductors on the face of the switchboard if only the operators are allowed access to the room, and the latter are protected by an insulating covering on the floor. The author does not approve of this rule, since carelessness or inadvertance may cause accidents. When it is necessary to have access to the rear of the board a passageway should be provided. This should be at least one metre in width and two metres high, and the floor covered with insulating material. The German rules require, further, that when there are conductors on both sides of this passageway, it shall be two metres wide with a dividing partition in the centre. They, however, do not call for insulating the latter. This is thought to be a defect, since it introduces a possible danger. Certain Swiss companies have adopted the plan of bringing all the conductors up to the front of the apparatus to which they are connected. This arrangement isolates the different circuits, and as the conductors are easily protected adds much to the safety of the installation. Outside conductors should be protected against contact with other lines. High-potential conductors should be bare, since outside insulation gives a false feeling of security to the workmen and, besides, it is soon stripped off. Metallic bodies in the neighborhood of high-tension lines should be treated as though they were conductors themselves, since they may acquire high static charges and thus become even more dangerous than the electrical conductors, because of their apparent harmlessness. The logical way to provide against accident from this cause would be to insulate all such bodies, but this is not always possible, though an insulated platform can always be arranged for the attendants.—*Translated and abstracted from L'Électricien (Paris), November 12.*

Design for the Edison Medal.

The meeting of the jury having the selection of a design for the Edison medal, which commemorates the invention of the incandescent lamp, was held in New York city, Wednesday, November 9, under the auspices of the National Sculpture Society, at the studio of Mr. J. Q. A. Ward, chairman of the committee. After a careful examination of the twenty-nine designs submitted in competition, the committee, by unanimous action, awarded the first prize of $1,000 for the successful design to Mr. James Earl Fraser. This includes the execution of the design in such shape and detail as will permit direct reduction to medal size. The second prize of $100 was awarded to Adolph A. Weinman, and the third prize of $50 to Miss Evelyn B. Longman. Mr. Fraser, the successful competitor, will develop his design for final consideration by the committee.

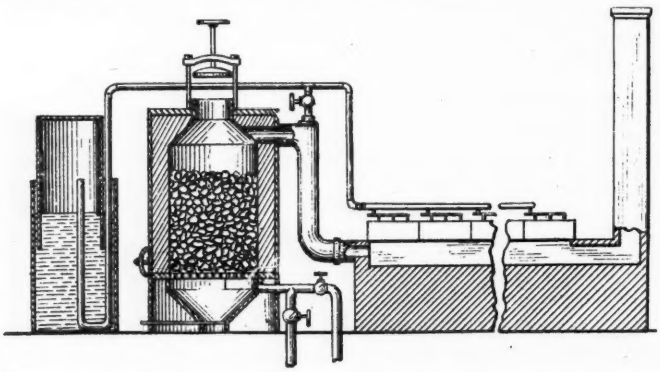
In addition to Chairman Ward, the other members of the committee are Daniel C. French, Augustus Saint Gaudens, of the National Sculpture Society, and Edward D. Adams and T. C. Martin for the Edison Medal Association and on behalf of the American Institute of Electrical Engineers.

The Physico-Chemical Review.

The *Physico-Chemical Review*, the first number of which appeared at the beginning of the present year, was started in order to create a comprehensive, centralizing, international review of progress in physical chemistry and the allied branches of chemistry and physics, in which should be reported in abstract—yet quickly, thoroughly and concisely—all the original work that is being done in these particular branches of science. The editor, Dr. Max Rudolphi, Physikalisches Institut der Technischen Hochschule, Darmstadt, Germany, is sending out a circular letter, requesting the cooperation of all interested in these sciences. To this end, he asks that all authors of papers send to him, within two months after the first appearance of the papers in print, an abstract for publication in the *Physico-Chemical Review*. These abstracts may be written in either English, French or German. They will be paid for at the rate of fifty marks per printed sheet of sixteen pages. All who agree to do this regularly will be given the privilege of subscribing to the *Physico-Chemical Review* at one-third less than the regular subscription price.

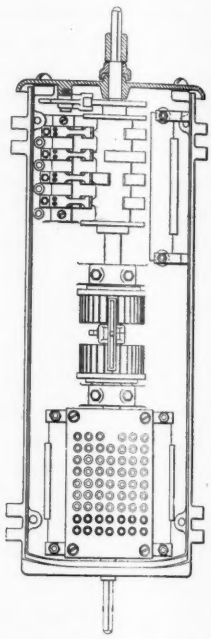
Electrical Patents.

Hugo Jone, of Chicago, Ill., has invented a method of converting the energy of fuel into electrical energy, and has recently obtained a patent (775,472, November 22) thereon. By "fuel" is meant any kind of combustible substance which is capable of reducing the oxide of some such metal as tin to the metal when heated with it, therefore, particularly the several kinds of carbon, pure and impure, the carbon compounds which are capable of effecting that reduction, and any gas which may be obtained from solid or liquid fuel by heating it with steam, as in the manufacture of water gas, or with carbon dioxide or some similar substance. In any case, the substance from which the electrical energy is generated is either the fuel itself or a substance reduced by the fuel. The invention consists substantially in producing an electric current in a galvanic cell, using a metal as the positive plate and carbon as the negative plate at an elevated temperature, and then reducing the metallic compound formed by the oxidation of the metal in the battery reaction by means of the oxidation energy of the carbonaceous fuel. The carbon electrode is an important means for the production of a strong current. It gives a much stronger current than most metals used as cathode. This is attributed largely to the position of carbon in the electrical-tension series of metals, which makes it possible to obtain a comparatively high electromotive force even with those metals which are but feebly electropositive, as the positive plate. How important an advantage this is will be more readily understood if it is considered that it is just the feebly electropositive metals which afford a high yield in the reduction by carbonaceous fuel. The elevated temperature serves chiefly the purpose of obtaining a high-current strength. By employing a carbon cathode at an elevated temperature it is made possible to obtain from a metal which is but moderately electropositive a current of both a comparatively high pressure and a comparatively high strength. Another feature of the invention consists in effecting the reduction of the battery product of the cell, which serves to recover the substance by the oxidation of which the electric current is generated in the cell itself and not in any special retort provided for that purpose and separate from the cell. In other words, the cell and the reducing retort are one and the same vessel, so that transference of chemicals from one to the other is obviated, and the reduction, as well as the oxidation, is continuous. These two effects are two of the objects of the invention. If the reduction is one which takes place at an elevated temperature and the battery reaction is one which takes place only at an elevated temperature, or more rapidly at that temperature, an additional benefit accrues from the combination of the reduction retort and the cell into one and the same vessel, namely, that of saving fuel, since the two vessels need no longer be heated separately, but may be heated jointly, they being one and the same vessel. This saving of fuel is then another object of the invention in cases where the cell is operated at an elevated temperature. Furthermore, as neither the oxidation nor the reduction need be interrupted for the purpose of removing chemicals, the cooling down of the vessels in which these reactions take place ordinarily, which is connected with such interruption, and therefore the loss of heat connected with such interruption is avoided. Still another object is to have the electric current as strong as possible. To accomplish this, an effective depolarizer is provided, consisting not merely of atmospheric oxygen, but of a compound which is capable of deoxidation.



METHOD OF CONVERTING THE ENERGY OF FUEL INTO ELECTRICAL ENERGY.

Maxwell W. Day, of Schenectady, N. Y., has assigned to the General Electric Company a patent (775,445, November 22) granted to him on a controlling switch for electric circuits. The object of the invention is to provide in a single, compact structure means for opening and closing an electric circuit for reversing the direction of current flow therein, and for controlling the amount of current flow from zero through a large number of finely divided steps to maximum. The present invention has a controlling switch applied to a system of control for a generator and motor, both having separately excited fields, together with means for controlling the strength of one or both fields over wide ranges in order to obtain corresponding variations in the motor speed. The invention is not, however, limited to this specific application, but may be used to advantage in many cases in which it is desired to reverse and to control over wide ranges the current in an electric circuit. In the embodiment of the invention a generator and motor are provided, also a controlling switch which comprises a drum rotatable in either direction from its off position. Stationary contacts are adapted to be engaged by the drum, the contacts and drum being connected and arranged to connect the armature of the motor to the generator for either direction of rotation of the motor upon the movement of the drum in either direction from its off position. A movable member is employed rotatable with the drum, and adapted to engage two stationary commutators. Two resistances are connected, respectively, to the commutators, and movable members being arranged and connected to cut out alternately sections of the two resistances from the circuit of the generator field when the drum is moved in either direction from its off position.



CONTROLLING SWITCH FOR ELECTRICAL CIRCUITS.

THE ELECTRICAL FIRE HAZARD.[1]

C. J. H. WOODBURY.

Among these problems, subsidiary to the main questions of construction, operation and administration, is the relation of electricity to the fire hazard, for it is a principle in underwriting that every material possession subject to insurance is to its uttermost details also involved with questions of fire hazard, both external and internal.

While diminishing the hazards of other methods of illumination, with their attendant mishaps from direct flame, the uses of oil, gas explosions, and carelessness with friction matches, it must be conceded that electric lighting can not be claimed to be free from hazard.

Electric motors, in displacing gas and gasoline engines, or isolated steam boilers with careless attendants, can not be assumed to remove all fire risk merely because they displaced the burning of highly combustible materials.

In diminishing the use of these methods involving perilous hazard, there remains the possible electrical hazard, for this energy which is normally converted into heat at high temperature when it meets the resistance of arc or incandescent lamps, also produces similar temperatures adequate to ignite anything combustible whenever sufficient electrical energy is diverted from its normal conductors of low resistance and meets with a path of high resistance which converts into heat the portion of its energy devoted to the struggle for the maintenance of the circuit.

Virtually the whole of the precautions for the maintenance of conditions of safety may be summed in the provisions for adequate conductivity and efficient insulation, but in their application these provisions reach practically to every detail of all electrical plants.

THE UNDERWRITERS' RULES.

The early installations of electric lighting plants, whose circuits were upon uninsulated wires with earth return, caused numerous occurrences which naturally alarmed the underwriters. An investigation by a technical representative of a number of insurance companies and by those of the electric lighting interests was held, wherein the various incidents which had been the causes of fires were experimentally repeated, and new methods for the installation of plants prepared on behalf of the underwriters.

It was thus noted at the very inception of the commercial applications of electricity to interior lighting that the hazards could be minimized by arrangements which would improve rather than impair the operative conditions of the plant.

The feature of divesting a process of its dangerous elements initiated a new principle in fire insurance which has been widely extended in the technical treatment of various hazards, particularly those of manufacturing processes.

These electrical rules were extended along the lines of the advance of electrical applications, and various technical organizations, municipalities and local boards of underwriters, even individuals and manufacturers, prepared rules whose differences in unessential demands and deficiencies in specifications were sufficient to cause unnecessary vexation and frequent embarrassment, especially to the manufacturing and operative electrical interests.

In March, 1896, the National Conference on Standard Electrical Rules assembled in New York for the purpose of preparing a code, embodying specifications covering the conditions of safety in a manner equitable to all the interests involved.

This convention was composed of representatives of underwriters, of those engaged in the manufacture and operation of all varieties of applied electrical apparatus, and also of several scientific organizations.

The various rules were diligently compared and their provisions criticised, and the reports of these meetings with an extensive correspondence containing suggestions were referred to a committee who prepared the National Electrical Code, which was adopted by the National Board of Fire Underwriters and promulgated by them.

Their committee of electrical specialists meet at stated times to make such amendments, generally by way of addition rather than alteration, as may be necessary to keep in step with the advancing conditions.

It is submitted that this code represents a wider consensus of opinion upon a question of science applied to the service of mankind than was ever concurrently given to any similar question.

These rules are anomalous in their functions. They set forth conditions governing methods of construction, installation and operation of electrical plants, and their specifications receive the utmost consideration from those to whom they apply.

Promulgated by the National Board of Fire Underwriters, they form in their applications the guidance of inspectors of voluntary associations of representatives of insurance companies, and do not rest upon any jurisdiction which has power to enforce compliance with their provisions in any manner comparable with the power of the law.

The work of the inspection corps is primarily suggestive in its nature, and as a division it is separate from the insurance rate-making bodies, who, however, consider the electrical conditions in connection with other facts bearing upon estimates of risk.

In the consideration of the functions and jurisdiction of these rules, it must be remembered that there can be no exercise of authority without a corresponding measure of responsibility, and as these rules treat upon about everything connected with applied electricity, the situation year by year becomes greater and more complex. There is an approach to problems which in the near future may need a stronger body than a voluntary organization, whatever may be the individual constituency of its members, to treat upon the large subjects arising from the congestion of various electric applications, and this administration of the National Electrical Code is being watched with interest, in comparison with that of the methods used under the authority of the law in various countries on the other side of the Atlantic.

This is no disparagement to the valuable work of the Electrical Committee in the advancement of standards of electrical installation and proscription of inferior methods to remark that in the confidence of equitable treatment, the electrical interests have cooperated with the underwriters in giving of their specialized skill towards the solution of the difficulties of hazard which have been raised. The improvements of their own apparatus have contained the suggestions of new rules. Slate switchboards made by electrical lighting companies inspired rules asking for slate switchboards; tubular fuses begat rules to match; telephone companies made protectors to defend their harmless plant, and protectors were demanded; power plants were equipped with circuit closers, and such devices became enruled. Study the evolution of these rules as one may, it will be seen that throughout the whole code the electrical interests were the pioneers in the means for the preservation of plant and the maintenance of continuous service.

All electrical interests appreciate the

[1] Abstract of an address before the Brooklyn Institute of Arts and Sciences, December 6.

value of standardization of methods and expect a similar consistency in their application.

The speaker then discussed in detail the hazards arising in the various applications of electricity and the means adopted to protect against them.

THE UNDERWRITERS' ELECTRICAL BUREAU.

The whole foundation of fire insurance, which is said to be a second single tax in this country, is based upon a distribution of averages, and in that examination of facts which is the foundation of science, the allotment of the various losses both as to cause and amount is the subject of systematic tabulation, whose results furnish the basis upon which insurance rates are levied, for the old method of competitive guessing is a matter of the past.

The National Board of Fire Underwriters maintain a testing laboratory which contains the necessary facilities for making the various investigations required in this study of matters pertaining to the fire hazard.

It is here that the supplies and subsidiary devices of commercial electricity are put to their proper tests, and the results have great weight in furnishing additional features to the National Electrical Code. Their quarterly reports, containing lists of fires caused by electricity, and stating the deviations from the code which are supposed to have been the origin, is a compendium of exact information on the subject.

The Associated Factory Mutual Insurance Companies of New England were pioneers in the application of technical work to the reduction of the fire loss, a task whose beneficient results have extended beyond the mills from the specialty of this combination.

The underwriters assume a great task in undertaking to maintain inspections properties over as widely extended and as numerous in detail as that of the commercial applications of electricity.

The results show peradventure that the electrical fire hazard is less than that of other methods of lighting and power transmission, while every telephone, being a fire-alarm, the signalling systems are potent elements in the reduction of the fire loss.

While the diminution of the ratio of such fire losses appears to be due to this work, as the variable element in the problem, the question naturally arises, will the future permit its continuation to an extent which will be equal to the greater task of meeting the problems of depreciation of plant, and the congestion of the future to which the present applications of electricity are a mere preface.

If the work remains in hands which can exercise the responsibilities to a uniform jurisdiction, then it will be sustained by the dominance of an approving public sentiment.

Evening Lectures in Electricity at the Polytechnic Institute, Brooklyn, N. Y.

The Polytechnic Institute, of Brooklyn, has established an evening course in electrical engineering. As previously announced, the course will consist of a series of lectures by engineers who have been prominently identified with successful engineering, covering a number of years' experience. The schedule of lectures is as follows:

Four two-hour lectures on "Commercial Electrical Engineering," by Professor Scott.

December 21. Training and Qualifications of a Commercial Electrical Engineer.

January 25. The Design and Construction of Electrical Machinery.

February 16. The Testing of Electrical Machinery at the Works.

March 16. The Engineer Salesman.

Eight two-hour lectures on "Electrical Power Transmission," by Professor Perrine.

February 9. Economics of Transmission Problems.

February 23. Complete Watershed and Waterflow Investigation.

March 9. High and Low Head Hydraulic Machinery.

March 23. Electrical Machinery Adapted to Long-Distance Power Transmission.

April 6. Problems Involved in the Location of Transmission Lines.

April 19. The Construction of the Transmission Line.

May 4. High and Low-Tension Distribution Especially Applicable to Long-Distance Plants.

May 18. Competitors of Electrical Long-Distance Transmission and Transmission from Coal and Gas Fields.

Eight two-hour lectures on "Central Station Practice," by Professor Barstow.

December 15. Local Conditions Governing the Selection of the System.

December 20. Arrangement and Installation of Equipment.

January 5. The Steam Plant.

January 17. The Electrical Plant.

January 31. Switchboards.

February 14. Distributing Systems.

February 28. Metering.

March 14. Organization and Management.

Eight two-hour lectures on "Telephony, Telegraphy, and Patent Practice," by Professor Lockwood.

February 7. The Speaking Telephone; Its History and Principles, and Users' Instruments.

February 21. Telephone Lines and Cables.

March 7. Central Station Equipment and Arrangement.

March 21. The Telephone Exchange Switchboard; with Particular Reference to Multiple Switchboards.

April 4. Party lines and Selective Call Signal Systems.

April 18. Land Telegraphy; with Some Notice of Special Systems.

May 2. Submarine Telegraphy.

May 15. Inventions, Patents and Patent Practice.

Eight two-hour lectures on "Electric Traction," by Professor Duncan.

February 15. General Consideration of Load Factors and Cost Factors.

March 2. Car and Train Resistance, Track Construction, Interurban Roads and City Tramways.

March 15. Conduit Roads and Special Sectional Roads.

March 30. Distribution for Electric Roads, Boosters and Storage Batteries.

April 13. Characteristics of Direct and Alternating-Current Railway Motors.

April 27. Schedules and Motor Capacity.

May 11. Motor Capacity, Gear Ratio, and Braking

May 25. Economics of Electric Railroading.

The lectures will be given in the Polytechnic Institute, Brooklyn, starting promptly at 7.30 in the evening. The subscription for the series is $25 or $7.50 for each course of eight lectures, or $4 for Professor Scott's course. Admission is free to all undergraduate students of the Polytechnic Institute. The attendance of seniors in electrical engineering is compulsory. From them, and from all who desire attendance at these lectures to be counted in satisfying the requirements for the degree of electrical engineering, numerous reports in professional form, concerning engineering problems, set by the lecturers, and germane to their subjects, will be required.

Arrangements will be made to give evening instruction in laboratory tests, mathematics or other subjects that are required for the degree of electrical engineer, provided there be a sufficient number of applications to guarantee the expense.

Fred W. Atkinson is president of the Polytechnic Institute, and Samuel Sheldon, department chief and professor of physics and electrical engineering. Charles F. Scott is consulting professor of commercial electrical engineering; Louis Duncan, consulting professor of electric traction; Frederick A. C. Perrine, consulting professor of long-distance electric power transmission; Thomas D. Lockwood, consulting professor of telephony, telegraphy and patent practice; William S. Barstow, consulting professor of central-station practice, and Sidney W. Ashe, instructor in physics and electrical engineering.

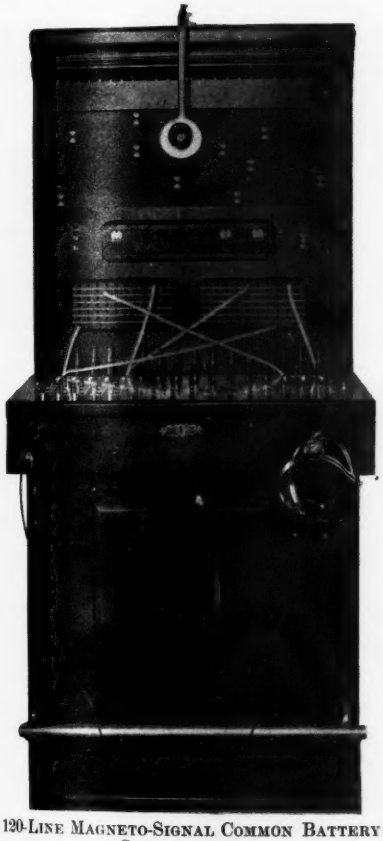
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Telephone Equipment Made by the Wotton Electric and Manufacturing Company.

The Wotton Electric and Manufacturing Company, of Atlanta, Ga., manufactures a line of telephone equipment, including switchboards, wall and desk sets, extension bells, etc., some of which are shown in the accompanying illustrations.

A typical common battery switchboard with magnetic signal is shown herewith. The switchboard with lamp signal is shown in one of these illustrations, with keyboard removed in order to show the wiring.



120-LINE MAGNETO-SIGNAL COMMON BATTERY SWITCHBOARD.

225-LINE COMMON BATTERY SWITCHBOARD, LAMP SIGNAL, SHOWING KEYBOARD WIRING.

The framework is made of San Domingo mahogany, or quartered oak, as specified. It is thoroughly put together and finished in the regular standard dull switchboard finish.

The wiring is always put in complete, no matter what the equipment of the board may be, so that the customer in installing additional equipment does not have to go to the trouble and expense of extra wiring. The wires are all attached to a terminal board and fastened by soldering to brass clips, the other ends of which are used for attaching the wires leading from the intermediate or main distributing frame. The terminals of the circuits are plainly marked. A 100-wire switchboard may be installed and put in working order within three hours, if necessary.

The keyboard is laid up in three layers with grains crossed to prevent warping. The boards are properly hinged, and are supplied with a standard switchboard lock. Combined ringing and listening keys are used, and all movable contacts are of platinum, no silver contacts being used in any portion of the board. The combined ringing and listening keys are of a design that has been approved by long years of service, and have been found to give uniformly satisfactory results. The throwing of the lever in one direction enables the operator to answer on the line, and in the other direction enables her to ring out on the calling plug in the usual standard manner.

The cord circuits are made as specified by the customer, but where no specification is given, the regular standard repeating-coil circuit of the Wotton company is used.

Lamp clearing-out signals are used on all common battery switchboards, although magnetic signals are supplied, if desired. There are two signals to each pair of cords, thus giving the operator complete visual supervision of the connections, enabling her to attend to a much larger number of subscribers than would be otherwise possible.

The jacks are mounted in hard rubber with eighteen per cent German silver springs, and platinum contact points. These contact points are thoroughly riveted into the springs, and no solder is used about them.

In the magnetic line signals there is only one moving part. The act of taking the telephone from its hook sends current through the winding of the signal, and sets the disc in a position to call the attention of the operator instantly. At the same time it rings the night-bell if the same is in circuit. There is only one contact for the entire switchboard for

the night-bell relay, and the relay actuating this contact is in an easily accessible position.

Provision is made in all of these switchboards for the operation of a specified number of toll lines, regular standard tubular magneto drops being used for this service. The drops are in all cases of the bridging type.

The switchboards are in all cases thoroughly tested before they leave the factory. The signals are all protected with a plate-glass front, and provision is made for removing any signal without disturbing the others, in case of any accidental damage thereto by lightning or otherwise. Magneto bells for exchange and private line work are also made by this company. The bell boxes are made up in quartered oak, walnut or mahogany, as specified. The boxes are put together in the most substantial manner of kiln-dried lumber, and are handsomely finished.

The generators are made with laminated armatures. The pole-pieces are of malleable iron. The magnets are of a special magnet steel of high price and best quality. The generators are all tested before being placed in the bell, and when run at a constant speed of 1,000 revolutions per minute give a voltage of 125 at the terminals. Generators that fail to come up to 125 volts under the above conditions are rejected.

The ringers are of the double-spool type, polarized by one permanent magnet. The whole moving mechanism is in line, and the ringer is entirely self-contained. The gongs are not mounted on posts fastened to the woodwork, but are mounted on a part of the framework of the ringer. Lock nuts are provided for all adjusting screws. The gongs are adjusted by simply loosening their clamping nuts and turning them on their posts; the hole being stamped slightly off centre on the gong enables a wide range of adjustment to be made by this very simple and effective means. In the bridging bells the ringer magnets are wound from 1,000 to 2,500 ohms, as specified. In the whole mechanism there is nothing that has not been tested by continuous service under the severest conditions.

On all the bells the same type of self-contained automatic hook is used. In these bells the hook proper does not form a part of the circuit, but is thoroughly insulated by hard rubber from any of the contacts. This is a valuable feature as it prevents the possibility of the user receiving a shock while handling the hook. In all the bells, platinum points are used throughout for all movable contacts, thus making them serviceable under all conditions, and in all localities.

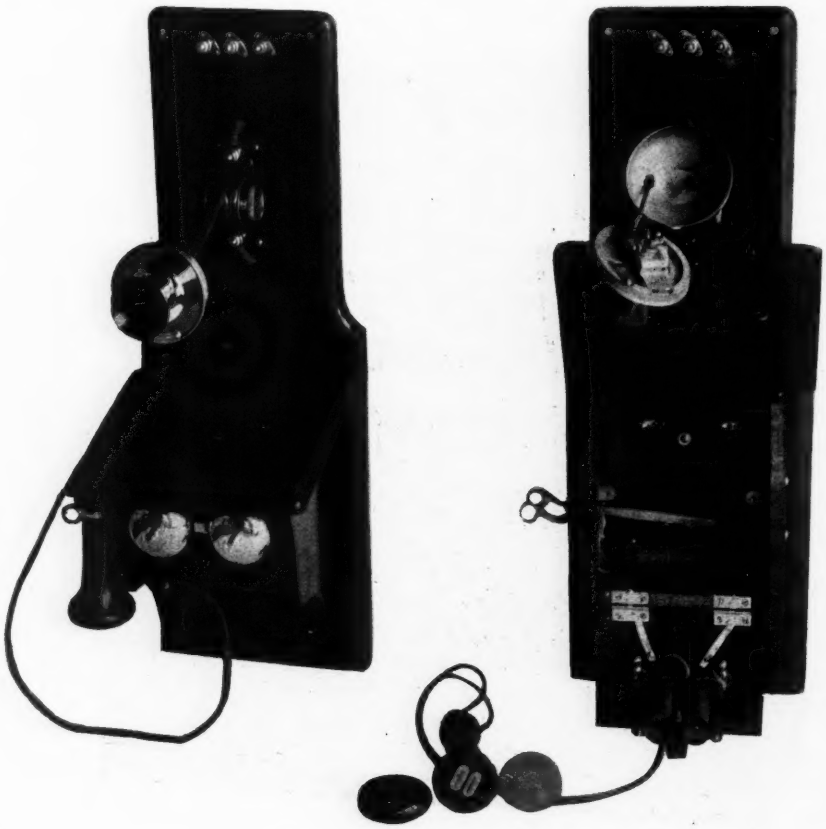
Patented spring hinges are used for ensuring contact to the terminals of the ringer, the ringer being mounted on the door in the usual way, and connections thereto made through the two hinges of the box. Exposed binding-posts are placed on all the bells, enabling them to be put up and taken down readily without cutting wires, or without removing the whole instrument from the wall. The connections to the binding-posts are soldered to an integral part of the post.

When desired, magneto bells suitable for individual ringing on party lines are supplied. These bells are made with a commutator, and generate a direct current that will throw the drop at the central office, but will not ring up other stations on the same circuit.

The bells are so arranged that by merely changing one connection from one point to another they are converted either to direct-current bells or alternating-current bells, as desired.

Biased ringers are supplied when specified, making them suitable for use with pulsating currents.

The extension bell has been developed in response to a demand for a bell to be used on telephone lines in noisy places. One of the illustrations shows the construction of the gongs very clearly. They are furnished wound to any resistance from 80 to 2,500 ohms, and are, there-



Common Battery Wall Set.

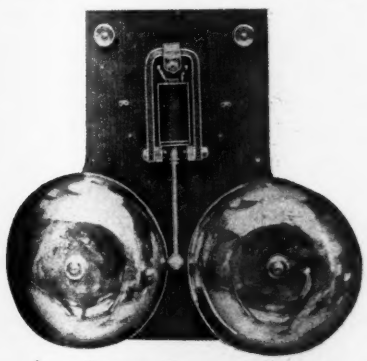
Common Battery Desk Set, Complete.

fore, suited to any class of telephone circuit. Means for adjusting the bells are provided so they can be made to ring loud enough to suit any locality. The separation of the gongs is changed by merely loosening the clamping nuts and turning the gongs on their posts. All other necessary adjustments are provided for in an equally simple manner. The base is so arranged that a two microfarad

Six-Station Intercommunication Wall Set.

condenser can be mounted therein, and when this is done the bell is ready to be placed on any common battery telephone circuit. The condenser, being mounted in series with the bell coil, prevents a false signal being sent in, while it does not affect the ringing of the bell appreciably.

For series lines the bells are wound from 80 to 200 ohms and the bell is con-



Loud Ringing Extension Gongs.

nected in series with the ringer, and so wired that the automatic hook cuts out both the magneto bell ringer and the extension bell when the telephone is removed from its hook. No condensers are required for this class of circuit.

The 1,000-ohm bell can be rung through an external resistance of 10,000 ohms with the ordinary generator of the magneto bell; therefore, these gongs are particularly well adapted for use on private lines in such places where, on account of noise of machinery in operation, or from other causes, the ordinary bell would not attract attention.

No battery drops or other auxiliary apparatus are required, as the bells are directly under the control of the operator, and the ring, therefore, can be made as long or short as may be necessary. Condensers are supplied, when desired, with bells having a resistance of 1,000 ohms or over. The gongs are mounted in hard-wood bases, and are finished either in quartered oak, cherry or mahogany, as desired.

This company also manufactures a line of transformers for surgical work.

The construction of the transformers enables them to be made with two or more secondaries, so that in addition to their use for cautery work they may also be employed for faradic purposes.

The faradic coil, with which the transformers are supplied, may be used for lighting miniature lamps up to 125 volts. The means whereby the secondary regulation is secured is extremely simple and efficient. Instead of being a step-by-step method, the regulation is effected by simply sliding the primary coil in or out of the secondary coil, and the motion is so controlled that the voltage of the secondary coil may be raised or lowered by almost infinitesimal degrees. The fact that the primary coil is immovable with respect to the secondary of the transformer necessitates supporting the latter independently, thus ensuring high insulation. In fact, the two coils never approach nearer than one-quarter of an inch of each other. There is, therefore, no possibility of a cross occurring between the two circuits. The ends of the secondary coil are rigidly fastened to binding-posts, from which the current is conducted to the cautery knife.

Transformers are built to operate with both alternating and direct currents. The transformer for use with alternating currents operates on circuits of any commercial frequency, and in case of any change in the service circuits from alternating to direct, or *vice versa,* the same transformer is used. When operated from direct-current circuits a special interrupter is used, which has been in service for some years, and has given uniformly satisfactory results.

Transformers are finished in quartered oak, but on special order any standard wood is furnished.

The telephone condensers made by this company have uniform capacity, ability to stand high voltage without breakdown and high insulation resistance.

They are so constructed as to withstand at least 250 volts alternating current indefinitely, without breaking down or leaking appreciably, and have an insulation resistance of at least forty megohms per microfarad. Their capacity does not vary more than five per cent from the rated capacity. The condensers are neatly and hermetically sealed in metal cases, mounted with first grade hard rubber terminals and tinned brass terminal lugs.

Specialties for Telephone Service.

James S. Barron & Company, 339-343 Greenwich street, New York city, supplies a number of specialties for telephone and telegraph service. Among other material which this company manufactures, and which has been received with great success in the telephone and telegraph field, are the H.-P. rustless cable-hanger and Paul's "Glitterene." The H.-P. rustless cable-hanger is being adopted by some of the largest telephone companies. The manufacturer reports large and increasing sales, which have amounted to nearly

H.-P. Rustless Cable Clip.

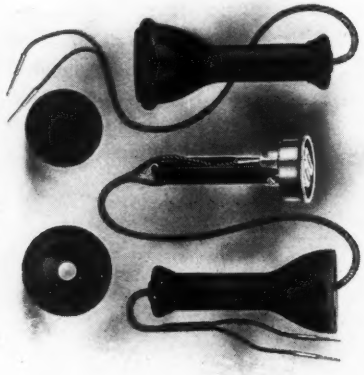
a million in the last three years. Some advantages claimed for this hanger are its construction of zinc, and in one piece. There is no ring nor hook to rust out and allow the cable to fall; neither are there any parts to assemble. The operation of applying the hangers is simple and quickly performed. The hangers are used on lines where the cables are run over temporary supports, hooks or cable blocks, and are applied from messenger cars. The circular end of the hanger is held against the cable wall, the free end is wound around, passed through the lower slot, around again through the upper slot, over the suspension wire, d then hooked into the upper slot.

Paul's "Glitterene" is claimed to be

free from all mineral acids, and is a quick polisher. The compound is especially adapted for cleaning and polishing telephones, and for use around switchboards and delicate instruments. It is made from the best materials, under the direction of one of the leading chemists of the country, with special machinery. This machinery makes the material entirely homogeneous, while preserving its full strength. The manufacturer claims that it leaves no stain, and that a very small quantity is sufficient to give the best results.

Telephone Apparatus Manufactured by the Williams Telephone and Supply Company.

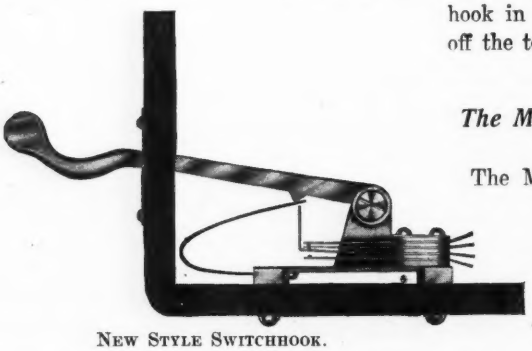
The Williams Telephone and Supply Company, Cleveland, Ohio, has recently added to its telephone instrument a new



Concealed Cord Receiver.

style of switch hook and a new form of concealed cord receiver. These are shown in the accompanying illustrations.

The new switch hook has genuine platinum contacts, and is proof against



New Style Switchhook.

grounding or short-circuiting. The hook has four contacts and no pivot connections, four springs being used, which readily connect to the ringing and talking circuits. Neither the lifting spring, the hinged joint nor the frame is used as a part of the electric contact. This eliminates all possibility of loose contacts in these positions. The platinum points used furnish a positive electric contact in all climates and under all conditions of temperature. The springs are so adjusted that they afford perfect balance. The hook is self-contained, and can be taken out for any purpose without disturbing the other parts of the telephone. The lifting spring is of tempered steel, and is always uniform in its tension.

The concealed cord, bipolar receiver embodies all the essential features of the company's old-style receiver, which has become well and favorably known because of its permanent adjustment under all changes of temperature. Permanent adjustment is secured by using a metal adjustment cup and adjustment plate seating against a metal backing, and the two metals expanding and contracting together. A long, permanent magnet is used, giving increased magnetic flux and a clearer articulation.

A feature of this receiver is that a common cord can be used, without a special form of terminal tip. The receiver is centrally hung, and all strain on the cord is taken up by a ring fastened around the head of the magnet, and attached to a hook in the cord, all strain being taken off the terminal tips.

The Measured Service Company's Apparatus.

The Measured Service Company, 153-159 South Jefferson street, Chicago, Ill., has placed upon the market a new device for registering telephone calls. This instrument is designed to be placed at the substation, and used for the benefit of the subscribers. When a connection is made, the calling party pulls a lever which throws a buzz over the wire, notifying the operator that he has registered. This call is shown on the face of the meter. At the end of a certain period, when it is required to take statements, the record taker or central office machine is placed in connection with the substation device. The party is called and asked to turn the

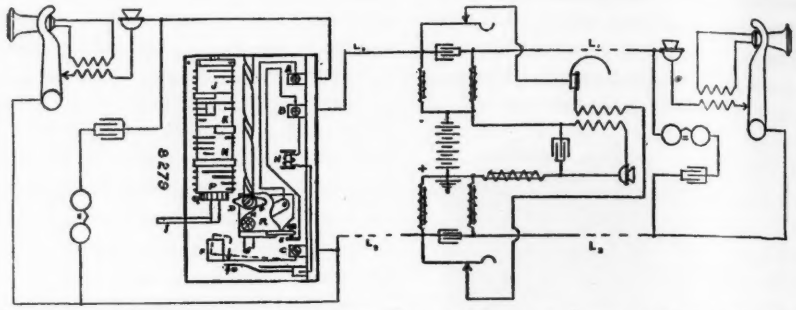
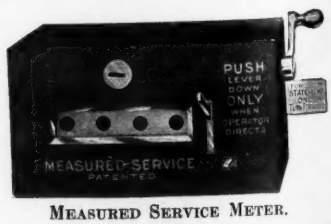


Diagram of Connection for Measuring Service Meter in Central Energy Systems.

crank. This operation makes a statement on a tape by Morse code at the central office of the number of calls made since the last reading.

The accompanying illustration shows the measured service meter, and a diagram of wiring for the measuring service device.

Where the apparatus is used with a local battery magneto call service, the subscriber's station instruments consist of the regular telephone equipment, with the addition of the meter. The circuits at the substation are so arranged that when the telephone user draws down the call-recording lever, it results in short-circuiting the line several times in quick succession. At the central switchboard the line circuits are not changed in any way from existing conditions, nor are the cord circuits changed in any respect. From a limited call station line a call to central from the subscriber would be handled essentially as follows: the subscriber turns his magneto and sends a calling current over the circuit. The operator, upon receiving this call, places a connecting plug into the jack corresponding to the fallen shutter, cutting in her telephone set and making the usual enquiry. After learning the number of the line



Measured Service Meter.

with which the calling subscriber desires to be connected, the operator proceeds to ring the called-for subscriber's bell. The moment that the called-for subscriber responds, and before permitting the subscribers to carry on their conversation, the

operator requests the calling subscriber to pull down the recording lever, and upon his complying with this request the buzzer operates, notifying the operator that the subscriber has complied with the request.

In order to read the calls of the subscriber at the central office, a switching plug is installed with an ordinary telegraph relay in series with ten or fifteen cells of dry battery. In addition to this the contacts of the relay are connected to the magnet and battery of a standard telegraph register. With this apparatus a short-circuiting of the connecting plug results in the telegraph relay pulling up its armature and closing its local circuit, comprising the telegraph register, magnet and battery. As long as the plug remains short-circuited, the telegraph relay remains drawn up, and the telegraph register key produces an imprint on the tape.

If a certain number of calls have been made from a given station, and the central office attendant desires to have made a record of the calls, a connecting plug is placed in the subscriber's spring jack. After calling up the subscriber, a request is made that he pull forward the record-taking crank to the right of the call box. When the subscriber complies with this request, he causes the telephone circuit to be opened. Furthermore, he causes a wiper contact-maker to automatically pass over the contact points of the recording cylinders. It is understood, therefore, that when the subscriber pulls forward the crank, his own circuit is opened, but the contact-making wiper is caused to automatically travel back over the contacts on the cylinder and produce momentarily closed circuits of the line, causing these momentarily closed circuits to record on the tape of the telegraph register at the central office. When the wiper is passed over the entire series of contacts, then the subscriber's telephone circuit is again closed and the central office attendant, observing that the record has been properly received, dismisses the subscriber with the information that the record has been taken. In this way the subscriber may be informed of the exact number of calls recorded, permitting him to compare this statement with the record numbers visible to him by observing the exposed numbers upon the recording cylinders through the glass face of the meter in the substation.

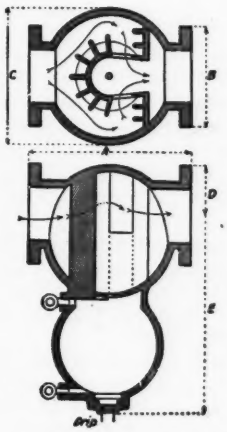
This is the method of operation, whether arranged for magneto call, centralized call, or common battery. Certain modifications are necessary with differing line conditions. Almost every conceivable complexity has been considered, however, in the adapting of these meters for regular service, and the company is in a position to apply the meter to any system for the measuring of its service.

Baum Steam Separators.

Competition has forced the manufacturer of to-day to use every expedient for reducing costs and the steam separator is recognized as an important factor in reducing the cost of power. Losses that

HORIZONTAL STYLE FOR LIVE STEAM OR OIL SERVICE.

were once ignored are to-day seriously considered, as their bearing upon the dividend-paying ability of a property is fully appreciated.



TRANSVERSE AND VERTICAL SECTION, HORIZONTAL STYLE.

Dry steam means more power and greater longevity for the engine, and the elimination of cylinder oil, grit or grease from exhaust steam is a necessity where

VACUUM STYLE FOR CONDENSING SERVICE.

a heating system is involved and the condensation returned to the boiler.

Common-sense principles have been the guiding factor in the construction of Baum separators. The baffle plate converges toward the steam inlet in such a way that the incoming current is easily and naturally divided into two channels and separation effected with a minimum of back pressure. With a velocity not exceeding 6,000 feet per minute it has been proven that less than three-tenths of one per cent of the pressure is consumed in the Baum process of separation.

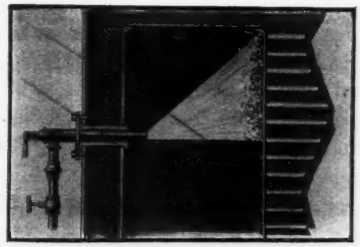
The general construction of the horizontal separator may be described as consisting of two hollow spheres joined by a short neck. The upper sphere contains the deflector, bridge and baffles, while the lower acts as the reservoir for separated water. This lower section is supplied with a water gauge and drip valve.

The transverse section shown is of the upper sphere and shows the ribbed curved deflector, the two inwardly projecting baffles and the side walled bridge spanning the neck and connecting baffles and deflector.

The Baum Separator and Machine Company, of Manheim, Pa., also manufactures a complete line of oil separators and its "patented vacuum system" seems to fulfill a long-felt want. A new catalogue, sent on request, fully describes and illustrates this system and also a line receiver separator for use on heavy steam lines in intermittent service.

New Boiler Flue Cleaner.

The Power Specialty Company, of Detroit, Mich., is placing on the market the "Diamond" steam flue blower, which in intended to remove soot from the flues of a steam boiler with a minimum expenditure of labor. This apparatus is shown in the accompanying illustration. The cleaner is placed permanently in the rear wall of the setting, and steam is admitted through the connections shown, thus blowing out the soot from the rear

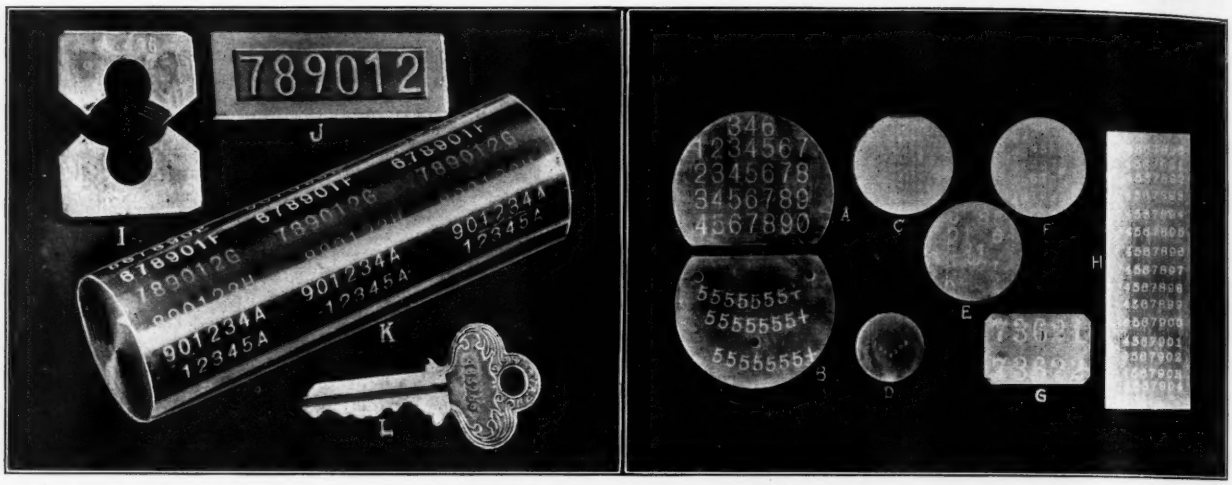


BOILER FLUE CLEANER.

into the uptake. In each operation a cluster of tubes about four feet in diameter is cleaned, and the cleaner can be turned so as to work over the entire rear head of the boiler.

Numbering Metal Parts.

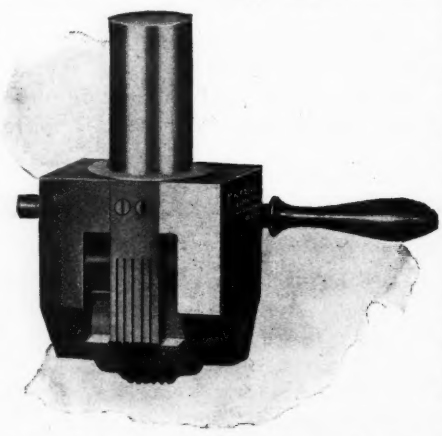
There is hardly a proposition connected with numbering metal parts which is not now successfully dealt with by small automatic machines specially designed to meet every requirement. These machines are provided with straight or tapered shanks of any size desired, and used in regular punch presses of suitable capacity. They are set up, adjusted and operated in much the same manner as an ordinary punch. That their practicability has been demonstrated may be seen from the following illustrations, representing pieces and parts actually numbered with them. Flat surfaces are numbered with straight alignment of figures, or the alignment may be curved to correspond to almost any radius, and thus improve the appearance of the numbering, or by economizing space increase the size and legibility of the figures. Letters or characters of any kind are provided for and any combination of them with figures may be instantly set in stamping position. Any size, style or shape of figure may be used, and any metal which can be machined is capable of being numbered by this process.



Reproduction of Metal Parts Stamped with Bates Numbering Machines.

Figs. A, B, D and G are pieces of brass, while Figs. C, E, F and H are hard-rolled steel stock. In Fig. B it will be observed that not only is the alignment curved, but the position of each figure radiates from a common centre, while in Fig. F the alignment is shown curving in the opposite position with the figures parallel to each other. Fig. D, with the number in the form of a letter V, shows one of the more difficult propositions, and was made for a well-known watch-case manufacturer, a design being placed above the figures and partly extending into the top of the V, thus producing a trade-mark easily recognized. This system of numbering, however, is not confined to flat surfaces, and it is practicable to number round, convex, concave and other surfaces presenting various radii. Fig. K is a piece of shafting, one and one-half inch diameter, and to number it the faces of the figures were made concave. Fig. J illustrates an embossed number. The material is a thin soft brass (0.006), and the machine was designed for numbering gas meter tags. The entire number with the panel was embossed at one stroke of the press, and the number automatically advanced. Fig. I is a set of standard adjustable dies. The match number is placed upon the back of each half of the die before the parts are finished and separated, thus assuring correct assembling.

Machines with double numbering movements for numbering both parts at one operation are used by some manufacturers. It will be observed that the illustrations show a high degree of excellence in the matter of the alignment and spacing of the figures, while the depth to which they are sunk is always uniform. The numbering is absolutely accurate, and in many instances the saving of time is so great that the entire equipment pays for itself in a few weeks or months, according to the extent to which it is used. Usually it becomes boys' work, and after the job is once set up an average of 1,000 pieces per hour can be numbered, or even greater rapidity attained as the feeder becomes expert.



Bates Numbering Machine, Model No. 43.

The equipment is manufactured by the Bates Machine Company, 346 Broadway, New York, and 2 Cooper street, Manchester, England. The company invites correspondence and is ready to deal with any proposition for numbering which may be submitted. Samples of machines and specimens of work will be forwarded with literature, upon application to either office.

Sound-Proof Telephone Booths.

The Yesbera Manufacturing Company, Toledo, Ohio, has placed on the market a number of styles of sound-proof telephone booths. The booths are made with double walls. The inside and outside walls both extend to the floor on which the booth stands. The edges of the booth floor fit into grooves plowed crossways of the inside walls. The inside walls are first put into position, and the edges of the side walls fit into grooves plowed lengthways of the front and back walls. The walls are drawn tightly together with screws at the corners of the booth. The outside walls are placed in position and fastened in the same manner as are the inside walls.

The ceiling fits over the inside walls and the top of the booth over the outside walls, giving a clear air space on all sides and at the top. The floor rests on felt cushions. The outside and inside walls are held the proper distance apart by four small cushioned blocks at the extreme corners of each side.

The door walls are separate, and swing on different sets of hinges, necessitating the use of an adjustable extension lock, which is supplied with each booth.

The booths are made of plain or quartered oak, or of birch, finished in mahogany. The wood is thoroughly filled, and the booth is given a rich rub finish inside and out.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC LIGHT PLANT IN SUEZ, EGYPT—A contract has been awarded to G. Beyts & Company, Suez, Egypt, for an electric light system for that city.

PENNSLYVANIA POWER PLANTS SOLD—Chicago capitalists have purchased the Gas and Electric Light Company, of Nanticoke; the Electric Light and Gas Company, of Plymouth; the Kingston Company and the Electric Light Company, of Wyoming, to light eleven towns. It is said the price paid for the property was $602,000. The capital of the consolidated company will be $1,000,000.

ELECTRIC PLANT ON THE SAN GERONIMO RIVER, MEXICO—A concession to the Villaneuva Company to establish an electric power plant on the San Geronimo river, in Guadalajara, has been granted by the Mexican government. The terms of the concession require that the surveys for the proposed plant shall be commenced within six months and that the construction be commenced within two years and that the whole plant be completed within seven years.

TO CONSOLIDATE POWER PLANTS IN NAVY YARDS—Messrs. Stone and Webster, electrical engineers, of Boston, Mass., have reported favorably on the consolidation of the power plants of the various departments in each navy yard. The report states that the yearly cost of consolidated supply would be less than at present by these amounts: Portsmouth, N. H., $20,000; Boston, $25,000; New York, $30,000; League Island, $18,000; Norfolk, $15,000, a total of $108,000.

SPOKANE SOUTHERN TRACTION COMPANY INCREASES CAPITAL—The Spokane Southern Traction Company, of Spokane, Wash., is increasing its capital stock from $500,000 to $2,000,000. Instead of building an electric road across Moran prairie it will build across the Palouse country to Colfax. A traffic contract has been made with the Washington Water Power Company to allow the Traction company to enter the city over the Power company's line and to interchange passengers on transfers.

ELECTRICITY ON THE LACKAWANNA RAILROAD—President W. H. Truesdale, of the Lackawanna Railroad, has issued the following statement, in relation to the use of electricity on the Lackawanna Railroad: "In a general way we have had in contemplation the question of operating trains between Hoboken and Montclair by electricity as soon as the improvements contemplated could be carried out, but we do not think it at all feasible or safe to undertake to equip our line to operate in this way until we can get rid of all the grade crossings on any such portion as we may so equip."

A POWER COMPANY IN SPARTANBURG AND UNION COUNTIES, S. C.—The Broad River Light and Power Company has been incorporated with capital stock of $1,000,000. It will build a power plant to supply the cotton mills of Spartanburg and Union counties, and to other manufacturing plants. A ten-foot dam, 1,000 feet long, will be built to develop 15,000 horse-power, which will be transmitted electrically a distance of twenty miles. A canal, one and one-half miles long, will be constructed. P. J. Balaguer is president, E. W. Wynne vice-president and F. K. Myers secretary-treasurer. They are all of Charleston, S. C.

CONTRACT FOR NIAGARA POWER—It is announced that the Ontario Power Company has made a contract with the Lockport Water Supply and Power Company for the sale of 30,000 horse-power, which is to be delivered by July 1, 1905. The contract also calls for an additional 30,000 horse-power to be delivered by January 1, 1907. The contract extends to April 1, 1950, with the right of renewal sixty years more. The power is to be delivered at the boundary line near the whirlpool, from which point a transmission line is to be built to Rochester by July 1, 1905. There is a forfeiture in case of the failure of either party to perform its part.

ELECTRICAL SECURITIES COMPANY OFFICERS—The officers of the Electrical Securities Company, organized recently by General Electric interests for the purpose of handling securities of electric companies, are: president, George R. Sheldon, New York; vice-president, E. R. Coffin, New York; secretary and treasurer, W. T. Kaufman, New York. The members of the executive committee are George R. Sheldon, W. C. Lane, Gordon Abbott, Marsden J. Perry, S. M. Hamill, Wilbur C. Fisk, E. R. Coffin and Henry W. Darling. The company has $2,000,000 common stock, all of which is owned by the General Electric Company, and $1,000,000 five per cent cumulative preferred stock.

KEYSTONE TELEPHONE COMPANY, OF PHILADELPHIA, REPORTED SOLD—It has been reported that the Commonwealth Electric Company, a newly organized corporation, has bought the entire conduit system of the Keystone Telephone Company, of Philadelphia, for $3,000,000, and that it will establish a competing electric light plant throughout the city. George R. Sheldon, of New York, treasurer of the North American Company of New Jersey, and John I. Beggs, now in St. Louis, a director of the same concern, are the prime organizers of the Commonwealth company. Other sources, however, state that the telephone company has refused to sell out to the Commonwealth Electric Company.

NIAGARA, LOCKPORT & ONTARIO INCREASES ITS CAPITAL STOCK—Papers have been filed at Albany recently increasing the capital stock of the Niagara, Lockport & Ontario Power Company from the nominal sum of $1,000 to $10,000,000. The new capital is divided equally into common and preferred stock. The development of the plans of the Niagara, Lockport & Ontario Power Company is expected to immediately follow the paying in of capital for the new stock. Within the last few months several power companies have been formed, including the Ontario Power Company, the Lockport Power Company and the Niagara, Lockport & Ontario Power Company.

NEW ELECTRIC LINE BETWEEN BOSTON AND PROVIDENCE—It has been announced that plans for the construction of an electric line between Boston and Providence, R. I., by the Boston & Providence Street Railway Company have been made. The line will be built through the city of Newton and the towns of Needham, Dover, Walpole, Norfolk, Wrenthem, North Attleboro and Attleboro to the Rhode Island state line. The line will be double-tracked and will run chiefly through private property. The running time between the two cities will be two hours and fifteen minutes. It is estimated that the road will cost $3,000,000, to be represented by $1,500,000 four and one-half per cent bonds and the remainder in stocks.

REORGANIZATION OF THE ORANGE COUNTY GAS AND ELECTRIC COMPANY—It is announced that Philip M. Jackson has secured a controlling interest in the Orange County Gas and Electric Company, of Middletown, N. Y., and will reorganize the company. The authorized capital stock of the company is $300,000, and the bonds amount to $300,000; $114,000 worth of these were issued to take up a prior mortgage on the company's plant, $86,000 worth were kept in the treasury, and $100,000 worth of bonds were sold. The name of the reorganized concern will be the Orange Lighting Company, and it will have an authorized capital stock of $100,000 and $300,000 of bonds, of which $114,000 will be used to wipe out the existing indebtedness and $86,000 applied for improving the plant.

A NEW INTERURBAN ELECTRIC ROAD PROPOSED IN IOWA—An organization was formed recently at Treynor, Iowa, with H. H. Van Brunt, of Council Bluffs, as president, and W. F. Pierce, of Carson, as secretary, for the purpose of building an electric road from Council Bluffs, Iowa, to Des Moines, Iowa, by way of Carson. The company is to have a capital of $250,000. It was also agreed that this company should join with any other

company that would secure a proportionate amount of stock for the construction of a line east of Carson to Des Moines so as to make possible a continuous line between Council Bluffs, Omaha and Des Moines. The length of the Council Bluffs-Des Moines line will be about 150 miles. It will tap a country populated by 400,000 people, containing an area of about 1,360,000 acres.

TROLLEY SERVICE BETWEEN CLEVELAND AND DETROIT—Trolley service between Detroit and Cleveland has been established with one change of cars at Toledo. Last week the Detroit, Monroe & Toledo short line ran its first cars from Toledo into the centre of Detroit from Toledo. The running time between Detroit and Toledo is three hours, but in a few weeks this will be reduced to two and one-half hours. Later limited cars will be put on which will make the fifty-eight miles in two hours. These cars will connect with the limited cars on the Lake Shore Electric Railway, running between Cleveland and Toledo, and the through schedule for 175 miles will be six hours and a half. The completion of the Toledo-Detroit line marks an important epoch in the history of the traction lines of the Central West, since it connects the great systems in Ohio and Michigan, making possible a trip of 350 miles from North East, Pa., to Port Huron, Mich.

ELECTRIC ROAD TO OPEN UP EASTERN WASHINGTON—It is announced that plans are completed for building a system of electric roads through Eastern Washington, covering a distance of 213 miles. The main line is to be from Spokane to Davenport and to the mouth of the Spokane river. It will connect above and below the rapids in the Columbia river. A branch will run south from Reardon, through Sprague and St. John, to Colfax. Another branch is to start at Davenport and run through Ritzville and Kalohtus to Snake river. Power is to be developed at the Narrows in Spokane river, a mile from the mouth, by a dam 150 feet wide and 100 feet high at the outlet of the cañon. This fall will develop 15,000 horse-power. The power plant and dam will cost $540,000, and the main line of eighty-one miles will be built at once. A bond issue of $3,000,000 has been arranged, and later another issue of $5,000,000 in bonds will be made. H. A. Lunceford, of Davenport, has made all the arrangements.

ORGANIZATION OF THE ATLANTA & CAROLINA RAILWAY COMPANY—The Atlanta & Carolina Railway Company, the proposed electric line between Greenville, S. C., and Atlanta, was formally organized November 25, 1904, at a meeting of the stockholders held in Atlanta. The capital stock of $50,000 was increased to $2,000,000. John R. Hosch, Dr. W. P. DeLapierre, John E. Hill, L. F. Sells, Henry Brazelton and Professor H. T. Edgerton, all of Hoschton; J. B. Thompson, of Gainesville, and James Sawyer, of Snellville, were elected directors of the company. The following officers were elected: John R. Hosch, president; J. B. Thompson, first vice-president; Dr. W. P. DeLapierre, second vice-president; Professor H. T. Edgerton, secretary; and Joseph A. McCord, of Atlanta, treasurer. C. J. Haden, of Atlanta, was elected attorney for the company. The right of way between Greenville and Atlanta will take in the towns of Lithonia, Lawrenceville, Hoschton, Jefferson, Commerce, Carnesville and Anderson.

TELEGRAPHIC COMMUNICATION BETWEEN THE UNITED STATES AND SIBERIA PLANNED—John Rosene, the managing director of the Northeastern Siberian Telegraphic Company, has proposed cable and telegraphic communication with Siberia and the Orient by way of Bering Strait. The plan is that the United States government extend its telegraph lines from Nome to Cape Prince of Wales. A wireless system will be established across Bering Strait between Cape Prince of Wales and East Cape, which is the nearest point to the Siberian side. The intervening distance is about thirty miles. He intimates that in the event of the United States government extending its line in this manner, the Northeastern Siberian Telegraph Company will build an overland telegraph line across northeastern Siberia, for which it holds a concession from the Russian government. This line would connect with the telegraph line which extends the full length of the trans-Siberian railway from Vladivostock to St. Petersburg. By this means, and by means of existing cable connections, Japan, China, the Philippines, Corea, Manchuria and other eastern countries will be placed in cable and telegraphic communication with all points on the North and South American continents.

NEW POWER PLANT IN IDAHO—Three power plants, a system of street railways through Clarkston and Lewiston, Ida., an immense reservoir for the Clarkston water system and the reconstruction of the main irrigation ditch from Asotin creek are being planned by the Lewiston-Clarkston Company. The surveys are about completed for the reservoir, which is to have a capacity of 20,000,000 gallons and will furnish the town of Clarkston with water. As soon as the surveys are completed work will be commenced. Work has been started on an auxiliary electric plant at the mouth of the Clearwater, which is to have a capacity of 1,000 horse-power. This plant will be fifty-two by eighty-three feet and will be built entirely of concrete and iron. For the next year it is probable this plant will be operated continually, as it is the intention to begin work enlarging the plant at Asotin creek when this one is finished. The Asotin plant will be increased from 600 horse-power to 2,500 horse-power. Work on a third electric plant, located on the Grand Ronde river, will also soon be started. This third plant is to have a capacity of 6,000 horse-power. As soon as the power is available from the Asotin plant it is the company's intention to start the installation of the electric railway system which is to traverse Lewiston. Some of the preliminary surveys for this have been made, but no definite route has been laid out. The power line to Moscow, Genesee and other towns is about completed and the current will soon be turned on.

INDIANAPOLIS, NEWCASTLE & TOLEDO ELECTRIC RAILWAY INCORPORATED—Papers were filed November 22, 1904, with the secretary of the state of Indiana, incorporating the Indianapolis, Newcastle & Toledo Electric Railway Company, with a capital stock of $3,500,000. The company is to build an electric railway, whose main line runs from Indianapolis, through Newcastle to Winchester. Branches will run from Newcastle to Richmond and from Newcastle to Muncie, also from Anderson to Shirley on the main line and from Maxwell on the main line to Greenfield. It is expected that the main line, from Indianapolis to Winchester, will be in operation by next fall. A number of companies are absorbed by the new company. Among these are the Newcastle & Winchester company, which was incorporated to build from Indianapolis to Winchester; also the proposed line of E. T. Ice between Newcastle and Muncie, and the line of Charles N. Mikels between Newcastle and Richmond. The lines of the new company will tap twenty-seven towns and cities in Indiana that at present have no connection with Indianapolis by electric roads. The population which will be served by this road, outside of Indianapolis, is estimated at about 150,000. In addition to passengers, freight will also be carried. The directors of the company are D. M. Parry, of Indianapolis, president; Charles S. Hernly, of Newcastle, vice-president and general manager; F. M. Ingler, of Newcastle, secretary and general counsel; Robert Churchman, of Indianapolis, treasurer; W. E. Stevenson, of Indianapolis; Ely Marvin, of Frankfort; Eugene H. Bundy, of Newcastle, and Charles N. Mikels, of Newcastle.

PERSONAL MENTION.

MR. V. K. HERLEN has been appointed manager of the Woodsfield (Ohio) Telephone Company. Important lines will be reconstructed and the business reorganized.

MR. OREN F. BROWNING has been admitted to partnership in the firm of Thayer Brothers & Company, 52 Broadway, New York city. He assumed the interest of the late Mr. John R. Thayer on December 1.

MR. R. A. MICKEY has been appointed secretary and sales manager of the American Carbon and Battery Company, St. Louis, Mo. Mr. Mickey was for eleven years assistant sales manager of the National Carbon Company, Cleveland, Ohio.

PROFESSOR C. P. STEINMETZ addressed the Society of Engineers of eastern New York at their meeting in Schenectady on December 1. The subject of his lecture was "The Electric Arc." The lecture was illustrated with experiments.

MR. JOHN B. JACKSON has been elected president of the consolidated interests of the Citizens' Traction Company, Citizens' Passenger Railway Company, Aspinwall Street Railway Company, Transverse Passenger Railway Company and Butler Street Railway Company, all operating in and around Pittsburg, Pa.

MR. NEWCOMB CARLTON has resigned as vice-president of the Bell Telephone Company, Buffalo, N. Y. Mr. Carlton is to be made a vice-president of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. It is probable that Mr. Carlton

will become president of the Niagara, Lockport & Ontario Power Company. His headquarters will be at the Westinghouse company's department in New York city at 120 Broadway.

MR. C. W. ANDERSON is temporarily acting as deputy colonial engineer at Singapore, Straits Settlements, India, *vice* Mr. Gaffney, deceased. Mr. Anderson is resident engineer of the Penang pier. Mr. May, senior superintendent of works, is now at Singapore, and it is thought he may be appointed deputy colonial engineer.

MR. RICHARD W. MEADE, assistant to the president of the New York City Railway Company, has been elected president of the New York Transportation Company, *vice* Mr. Henry Sanderson, resigned. Mr. Meade is a director of the New York Transportation Company. The executive duties performed by him as assistant to the president of the New York City Railway Company will hereafter devolve on Mr. Frank S. Gannon, vice-president.

MR. JOHN B. McDONALD was tendered a dinner by about 230 members of the Manhattan Club, on the evening of December 1. During the course of the evening a testimonial was presented to Mr. McDonald, in the form of a winged figure of Victory by Gasq. This figure is of green bronze, forty-eight inches high, poised upon a half globe. The affair was in recognition of the success of the subway enterprise which Mr. McDonald undertook four years ago.

MR. HARVEY M. LITTELL was a visitor to New York city last week. Mr. Littell is prominently identified with the electric railway interests of New York state and is vice-president of the Lima Electric Railway and Light Company, Lima, Ohio; general manager and purchasing agent of the United Railways, Light and Water Company, of Philadelphia, Pa., and general manager, purchasing agent, electrician and chief engineer of the Rapid Transit Company, of Chattanooga, Tenn.

MR. HENRY SANDERSON has resigned as president of the New York Transportation Company. The executive staff of the company, through Mr. H. H. Vreeland, presented the retiring president with a bronze desk set and engrossed resolutions. In making the presentation Mr. Vreeland took occasion to say that the business of the company had been virtually created during Mr. Sanderson's administration, and that during this time there had been developed a new and efficient means of transportation, which is now an essential part of the city's equipment. Mr. Sanderson's resignation took effect on November 30. He is to go into the banking business under the firm name of E. D. Brown & Sanderson.

ELECTRICAL SECURITIES.

The steel and iron trade advances during the past week continued to be used as a guide for speculative purposes. Notwithstanding the announcements from many commission houses, that public interest has waned perceptibly, the record of buying showed considerable activity. The fact that there has not been undue extravagance shown on the part of the outside investors points to the conclusion that the recklessness of 1901-1902 will not be repeated at this season. In many quarters it is assumed that unloading will be the order of the day for a short period. To offset this, however, there are continued reports of improved conditions in industry in general, and particularly in the transportation trade. Bank clearings also show that a much better state of affairs exists throughout the country. The latest government report on the cotton crop indicates that, with all allowances made, there will be a total output of 12,000,000 bales, as against 11,250,000 bales last year. The record of November business failures shows up with liabilities greatly decreased from the total of this time a year ago In many manufacturing centres, particularly in the machinery trade and in house-building and construction, there is a demand for skilled labor which it is being found hard to satisfy. At least one manufacturer of refined implements, covering almost every phase of tool work, reports a business condition which very closely approximates that of three years ago.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 3.

New York:	*Closing.*
Brooklyn Rapid Transit	68
Consolidated Gas	215
General Electric	191¼
Interborough Rapid Transit	166½
Kings County Electric	202
Manhattan Elevated	168
Metropolitan Street Railway	124¼
New York & New Jersey Telephone	165
Westinghouse Manufacturing Company	184

A quarterly dividend of 1½ per cent on the capital stock of the Manhattan Railway Company for the quarter ending December 31, 1904, and an additional dividend of 1 per cent for the nine months ending December 31, 1904, have been declared, in compliance with the terms of the lease of the Manhattan Railway Company to the Interborough Rapid Transit Company, payable on and after January 3, 1905. Transfer books closed December 9, and will reopen December 22.

Interborough Rapid Transit directors have declared a dividend of 3 per cent on all the capital stock of the company, payable January 3, 1905, at the office of August Belmont & Company, to holders of voting trust certificates of record December 10. Books close December 10 and reopen January 3. Interborough dividends will hereafter be made quarterly, on the first of April, July, October and January. The declaration of the dividend of 3 per cent makes a total of 5 per cent distributed by the Interborough company during the fiscal year.

Directors of the Westinghouse Electric and Manufacturing Company have declared the regular quarterly dividend of 2½ per cent on the preferred, assenting and non-assenting stocks, payable January 10. Books close December 28 and reopen January 11.

Boston:	*Closing.*
American Telephone and Telegraph	147½
Edison Electric Illuminating	252
Massachusetts Electric	62¾
New England Telephone	139½
Western Telephone and Telegraph preferred	100

At the recent meeting of the trustees of the Massachusetts Electric Companies the question of dividend declaration upon the preferred stock was not discussed. The 4 per cent dividend, however, is a cumulative issue, and it is anticipated that as a result of this winter's saving in expenses, the 2 per cent accumulation will be earned and the stock again placed upon a regular 4 per cent basis. Earnings of the companies this fall have been good, both gross and net.

The annual report of the Boston Elevated Railroad Company for the fiscal year ended September 30 is as follows: gross earnings, $12,436,594; operating expenses, $8,631,553; total net income, $3,805,041; charges, $2,975,268, and dividends, $798,000, leaving a surplus of $31,773, as compared with $28,955 for 1903, and $21,899 for 1902. The general balance sheet shows assets of $20,423,859, and liabilities of $18,064,397, leaving a surplus of $2,359,462.

Philadelphia:	*Closing.*
Electric Company of America	10¼
Electric Storage Battery common	81
Electric Storage Battery preferred	81
Philadelphia Electric	9¼
Philadelphia Rapid Transit	18
United Gas Improvement	106½

American Railways directors are reported to have formally considered a plan to lease the Electric Company of America on a basis of 4 per cent on a par $15 per share, increasing to 4½ per cent.

Chicago:	*Closing.*
Chicago Telephone	165
Chicago Edison Light	170
Metropolitan Elevated preferred	67
National Carbon common	44⅝
National Carbon preferred	109
Union Traction common	12
Union Traction preferred	43

Metropolitan Elevated daily passenger average during November was 115,803, an increase of 1,655.

Northwestern Elevated Company's daily average of passengers was 74,307, an increase of 2,885.

South Side Elevated for November showed a traffic of 85,160 passengers daily, an increase of 2¼ per cent over 1902. This can not be compared with November last year, as the road averaged 143,398 daily, owing to the City Railway strike.

The annual meeting of the Chicago Union Traction Company will be held January 10.

NEW INCORPORATIONS.

STAFFORD, OHIO—Stafford & Marietta Telephone Company. $10,000.

NASHVILLE, TENN.—Citizens' Telephone Company. Increased to $18,000.

NEWARK, N. J.—Citizens' Light and Power Company. Decreased from $1,500,000 to $10,000.

ANDERSON, S. C.—Piedmont Electric Company. $25,000. President and treasurer, E. S. Moorer.

CAMDEN, N J.—Delaware & Atlantic Telegraph and Telephone Company. Increased from $100,000 to $400,000.

LONE ROCK, WIS.—Lone Rock Telephone Company. $1,500. Incorporators: Andrew Harter, George Jamieson and H. A. Brace.

LITTLE ROCK, ARK.—Batesville Power Company. $10,000. Incorporators: F. P. Albright, A. R. Weaver, A. W. Ramsey and William Ramsey.

LEONARDSVILLE, N. Y.—Leonardsville Telephone Company. $1,000. Incorporators: E. S. Brand, J. A. Crandall, A. M. Coon, Leonardsville, N. Y.

CHRISNEY, IND.—Chrisney Electric Light Company. $1,500. Incorporators: J. C. Fella, B. N. Fisher, J. M. Fella, John B. Chrisney, T. E. Chrisney.

JAMAICA, N. Y.—Long Island Central Telephone and Telegraph Company. $5,000. Directors: E. H. Snedeker, F. N. Greene and F. D. Androcles, Jamaica.

COLUMBIA, S. C.—Par Shoals Power Company. $50,000. Incorporators: M. G. Houseal, C. H. Cannon and K. W. Sligh, all of Newberry, and C. L. Scott, of Greenville.

PORTLAND, ME.—Atlantic De Forest Wireless Company. To operate a wireless telegraph system. $500,000. President, M. W. Baldwin, Portland; treasurer, G. C. Knight, Portland.

SAN FRANCISCO, CAL.—Loon Lake Water and Power Company. $200,000. Incorporators: Stanley Forbes, Cleveland Forbes. Warren Gregory, C. M. Fitzgerald and W. H. Chickering.

PORTLAND, ME.—Fort Fairfield Electric Company. $40,000. President: H. L. Cram, Portland; treasurer, A. J. Desmond, Portland; directors, as above names and C. E. McGlauflin, Portland.

JERSEY CITY, N. J.—Northern Counties Construction Company. To construct and develop public works, including railroads, docks, telegraph, telephone and electric light lines and subways, etc.

AUSTIN, TEX.—El Paso Gas and Electric Company. To establish a gas and electric plant at El Paso, Tex. $500,000. Incorporators: Fletcher S. Heath, Frank R. Crane and Edward Clifford, of Chicago; William Barrett Ridgely, of Washington, D. C., and George F. Goodnow, of Waukegan, Ill.

LEGAL NOTE.

RAILROAD NOT REQUIRED TO PROTECT TRESPASSERS FROM THIRD RAIL—Judge John M. Thayer, of Hartford, Ct., has sustained the demurrer to the complaint in the suit of Patrick J. Powers against the New York, New Haven & Hartford Railroad Company, for the death of his three-year-old son, due to contact with the third rail belonging to the railroad. It was alleged that the third rail being a highly dangerous agency, it was the duty of the railroad company to protect it from the public. The railroad company, in its demurrer, said that the boy was a trespasser on its property, and that it owed him no duty in the way of protection. In sustaining the demurrer Judge Thayer says: "Assuming that the third rail, charged with electricity, was a very dangerous appliance, used by the defendant in its business upon its own property, the defendant was not bound to so protect it that the intestate could not under any circumstances fall upon it in stumbling. To make the complaint good facts must be alleged to show that in failing to protect it the defendant neglected a duty in this respect which it owed to the intestate, and that his death was caused by this negligence. The complaint fails to come up to this requirement. It does not appear that the intestate's death was in any way due to the defendant's failing to fence its tracks. So far as appears from the complaint the intestate may have stumbled and fallen from a car upon which he was being transported and crushed his skull by contact with the rail, or he may have been killed by the electric current after the contact."

TELEPHONE AND TELEGRAPH.

ROCKWELL, IOWA—The Iowa Telephone Company will build a line to Thornton.

REDONDO, CAL.—A fifty-year franchise has been granted the Home Telephone Company.

SAUK CENTRE, MINN.—The Sauk Centre telephone exchange has been sold to J. W. Ward.

YOUNGSTOWN, OHIO—The Central Union Telephone Company has opened an exchange at Lowellville.

MEXICO, MO.—The Mexico-Laddonia Telephone Company has asked for a franchise to establish a city exchange here.

NARRAGANSETT, R. I.—The town council has granted the Providence Telephone Company an exclusive franchise.

OMAHA, NEB.—The Nebraska Telephone Company will spend approximately $250,000 this coming year in improvements.

EVANSVILLE, IND.—The Cumberland Telephone Company has applied to the board of works for a forty-five-year franchise.

BRANTFORD, ONTARIO—The Bell Telephone Company will install a central energy switchboard in its headquarters in this city.

UTICA, N. Y.—The Central New York Telephone Company is improving its system at Rome. A new switchboard has been installed.

GREEN BAY, WIS.—Excavating has been started for the conduit system to be installed by the Valley Telephone and Telegraph Company.

RED CREEK, N. Y.—A local telephone exchange has been installed in this village under the direction of the Wayne-Monroe Telephone Company.

GRAND RAPIDS, MICH.—The Citizens' Telephone Company has purchased the exchange of the Luther Telephone Company with about forty-five telephones.

BRIDGEPORT, OHIO—The stockholders of the Bell Telephone Company have decided to double the capital stock of the company. The present capital stock is $75,000.

LOS ANGELES, CAL.—The Home Telephone Company has completed its long-distance connection from Riverside to Los Angeles and other southern California points.

STRATFORD, ONTARIO—Owing to the increased use of its lines the Bell Telephone Company has found it necessary to erect a new line between Toronto and London, *via* Stratford.

SAN FRANCISCO, CAL.—The telephone line from Goldfield to Bullfrog, projected by a number of the largest stockholders in the Bullfrog Mining Company, of Nevada, is now being built.

GREENSBORO, N. C.—The board of aldermen has adopted an ordinance requiring all telephone and telegraph wires on the principal business streets to be placed underground within twelve months.

PENN YAN, N. Y.—Men are at work on the extension of the Inter-Ocean Telephone and Telegraph Company's direct line from Penn Yan to Watkins. The line will be in working order by the first of January.

BOZEMAN, MONT.—The Yellowstone Park Telegraph and Telephone Company has brought its wires into Bozeman. The telephone service will include Big Timber, Helena and Butte, and will be extended later.

MADISONVILLE, TEX.—H. B. Huston has secured a franchise for putting in a telephone exchange in this city, and is taking active steps to get the system in operation in a few weeks. Mr. Huston has also secured long-distance connections.

CHASE CITY, VA.—A telephone line is being considered between this place and Red Oak, in Charlotte County, connecting with Drake's branch, Charlotte Courthouse and Lynchburg. Heretofore, the connection has been with points south and east only.

DENVER, COL.—The Chicago, Rock Island & Pacific is placing a telephone line between Denver and Colorado Springs and Goodland, Kan., the latter being the end of the division for the handling of trains and also for the transaction of railroad business.

NEW ORLEANS, LA.—Arrangements are being made by the Cumberland Telephone and Telegraph Company to double the capacity of its accommodations in the city and territory in the near

future. It is said that work on the proposed improvements will be begun at an early date.

FLINT, MICH.—It is said negotiations are on between the Valley Telephone Company, which has a line in this city, and the Citizens' Telephone Company, of Grand Rapids. Something in the nature of a union of the two companies is said to be involved.

PARIS, TENN.—At an adjourned session of the legislative council a fifty-year franchise was granted a new telephone company, to be operated and known as the Paris Telephone Company. This company will be required to place all wires underground within one-half block of the public square.

MISSOULA, MONT.—The Bell Telephone Company has all the material on the ground for the rural system that is to be installed in this section. The system is to be put through from Missoula to Hamilton and will touch all the towns along the line. At several of these exchanges are to be established.

MENOMINEE, MICH.—The Michigan Telephone Company has started the construction of an extension of its system from Menominee to Cedar River. The line will be thirty-two miles in length and is expected to go into commission in January. More than 1,000 poles will be used in its construction.

LANDER, WYO.—A company of Rock Springs capitalists has arranged to build a telephone line from Rock Springs to this city. The local authorities have granted the company a franchise, and work on the new line is to be commenced at once. When completed to this point from Rock Springs, the line will probably be extended to near-by towns.

INDEPENDENCE, ORE.— The organization of the Independence Mutual Telephone Company has been perfected. The following officers were elected: president, J. R. Craven; vice-president, W. W. Percival; treasurer, W. A. Messner. J. R. Craven, W. W. Percival, O. D. Butler, August Sperling and Walter Lyon were appointed an executive board.

WHEELING, W. VA.—At a recent meeting of the directors of the Belmont Telephone Company it was decided to call a special meeting of the stockholders for December 27 for the purpose of considering a proposition to increase the present capital stock of $75,000 to $150,000. The company anticipates extensions and improvements which call for the increase.

LANCASTER, OHIO—The stockholders of the Amanda Bell Telephone Company, which was incorporated several weeks ago, have completed organization. The company is incorporated for $5,000. The officers elected are: president, Theo. Lape; secretary, Walter Schleich, and treasurer, Samuel Simon. A line will be built to Clearport and one to Cedar Hill.

RIVERSIDE, CAL.—In an attempt to improve the telegraphic service along all lines of the road in southern California the Santa Fe now has a large force of men at work rebuilding its line between San Bernardino and Redlands. New and heavier wires are being used to replace the old. Already this improvement has been completed between Los Angeles and San Bernardino.

PHILADELPHIA, PA.—The question of increasing the capital stock of the Pennsylvania Telephone Company will be presented to the stockholders of the company at the annual meeting to be held at the general offices of the company January 25. It is proposed to increase the stock of the company from $3,000,000 to $5,000,000. The stockholders will also elect directors for the ensuing year.

SAULT STE. MARIE, MICH.—The Michigan State Telephone Company's service at the Soo is to be considerably improved next season. The present system is inadequate and much of it will be rebuilt. In the downtown district cables will take the place of the many single wires now doing duty. The company has about nine hundred subscribers and has been compelled to refuse applications owing to lack of pole room and other drawbacks.

PITTSBURG, PA.—The Pittsburg & Allegheny Telephone Company is arranging to build a new exchange for the hill districts back of Mt. Washington, which is to be put up at George and Orchard streets, Knoxville. The next exchange will be a two-story brick structure, with switchboard facilities for some time to come. At present the company is busy doing a large amount of line construction work in that section and will cover the entire field.

OSWEGO, N. Y.—Through its attorneys the Empire State Telephone Company has started to secure consents of property owners for the purpose of securing a franchise from the common council to put all its wires in the business section underground. The company's proposed improvement will cost about $40,000. The work can not be started this year, but the company proposes to get all the preliminary work done, so that it can be started in the spring.

STERLING, ILL.—The Interstate Telephone Company is at work stringing a new copper circuit from this city to Rock Island. When this line is completed the Interstate will have a direct toll line from Sterling to Rock Island. The cost of this improvement will be close to $12,000. The company will also string a new copper circuit from this city to Dixon. When this work is completed the Interstate will have three toll lines running to Dixon from Sterling.

WILMINGTON, N. C.—The Bell Telephone Company has completed the line between Wilmington and Mullins, S. C., which has been in course of construction for the past six months. The new line puts Wilmington and the country lying between this city and Mullins in direct communication with the entire South. Over the new line it is only 110 miles to Florence; it was over 250 on the old line. The construction of the new line gives Wilmington five long-distance circuits where there were only two eight months ago.

CHEHALIS, WASH.—The residents of Alpha, a rich agricultural section about twenty miles east of Chehalis, have raised the necessary funds and will build a rural telephone line from that point to Chehalis. The new line will become a part of the Home Telephone Company's line built last spring from Mossy Rock to Chehalis, a distance of thirty miles. Another extension of the Home company's line is also in process of construction from Mossy Rock to Nesika, up the Cowlitz valley, a distance of about fifteen miles.

CHICAGO, ILL.—Plans have been finished for the new building the Chicago Telephone Company is to put up on Washington street. The cost is to be $300,000. The building is to be six stories in height, with the foundations strong enough to carry ten more stories if it is decided to add them. The construction will be fireproof. Pond & Pond have designed the Humboldt exchange for the Chicago Telephone Company. It will be a two-story building, forty-nine by seventy-four feet, of brick and stone, and will be built at a cost of $30,000.

DAYTON, OHIO—The conditions under which the Middletown Home Telephone Company, a corporation composed of Dayton men, may construct a telephone system in Middletown, have been fixed by Judge Jones of the Butler County probate court. The company is to lay conduits in certain of the streets. No poles may be erected except for distribution purposes between Fifth and Ninth streets and then they must be erected in alleys as far as possible. All poles must be at least thirty-five feet high when erected. It is not probable that the commencement of the work will be ordered before spring.

DIXON, ILL.—The Dixon Home Telephone Company has taken over the holdings of the Lee County Telephone Company. The Dixon Home Telephone Company was recently incorporated with a capital stock of $125,000, the capitalization of the old company being $20,000, and the business will in the future be conducted under the above name. Arrangements have been made with the other independent telephone companies for a mutual interchange of business, which will enable the company to give to its patrons free service over the entire county and in addition Polo, Sterling and Rock Falls.

DENVER, COL.—An independent telephone system for Denver and most of the state of Colorado besides is planned by the El Paso Telephone Company, of Colorado City, which is incorporated under the laws of the state for $500,000. The first move in this independent campaign will be to wire the Cripple Creek district for telephone service, and then extend the work to Colorado City, Manitou and Colorado Springs. After this every mining camp in the district will be reached, and following on Florence, Canon City and other towns in that vicinity will get service. The promoters promise a maximum rate of $60 for a business telephone and a residence rate of $24.

ELECTRIC RAILWAYS.

BOSTON, MASS.—The Boston Elevated Railway Company has petitioned the railroad commission for authority to operate cars in the East Boston tunnel.

SANTA ROSA, CAL.—Regular hourly service has been established on the new Petaluma-Santa Rosa Railway, the first electric line to be built and operated in Sonoma County.

GAYLORD, MICH.—A meeting of local capitalists was held recently for the purpose of soliciting funds to build a new trolley line between Gaylord and Otsego. It is understood a right of way has already been obtained.

COUNCIL BLUFFS, IOWA—At a meeting of farmers and business men of Council Bluffs, Treynor and Carson, a committee was appointed to proceed with plans for the construction of the Council Bluffs-Carson electric line.

NORTH YAKIMA, WASH.—A corps of engineers is surveying the new route of the proposed railway system to connect Sunnyside with this place. The scheme is being pushed by Robert Strahorn, president of the Northwest Water and Light Company, of this city, who lives in Spokane.

COUNCIL BLUFFS, IOWA—A proposition to build an electric railway line from Carson to Council Bluffs by way of Treynor is being discussed. The Carson-Council Bluffs road would be twenty-six miles in length and pass through some of the best parts of Pottawattamie County.

GENEVA, IND.—J. H. Forbush, of Columbus, Ohio, and H. H. Horford, of Buchannan, Mich., of the Celina, Geneva & Marion Traction Company, have been making estimates of the cost of machinery, rolling stock and construction. They say that work will be commenced next spring.

KENOSHA, WIS.—A company is being formed to build a new electric railway line between Kenosha and Lake Geneva for freight and passengers, work to begin early in the spring. Kenosha and Chicago capitalists are behind the enterprise. The line will connect with the Fox River Valley line at Lake Geneva.

SANTA ROSA, CAL.—The board of supervisors has granted Solomon Scbocken and Oscar T. Webber, representing a company which proposes to construct an electric railway from Sonoma to tide water, a franchise over the route indicated. It is the opinion here that the line will eventually enter this city.

DURANGO, COL.—The Durango Realty and Railway Company held a meeting recently, when J. A. Porter was elected president, C. M. Williams, vice-president, and W. S. Pickrill, secretary and treasurer. The extension of the street railway to the park north of Animas City was authorized, and work will be started very soon.

OKLAHOMA CITY, O. T.—George F. Duncan and Edward Woodman, of Portland, Me., W. B. McKinley, of Champaign, Ill., and S. V. Nelson, of Fort Wayne, Ind., stockholders of the interurban electric line from this city to Sulphur Springs, I. T., announce that the line will be built at once. The survey has been finished.

DES MOINES, IOWA—The Des Moines City Railway Company has concluded the purchase of a lot in East Des Moines. This property adjoins the company's power-house and construction-shop plant on the east side, and is wanted for extensions to the car building plant that are contemplated for next season. The property comprises a little over a city block.

STEUBENVILLE, OHIO—The commissioners of Jefferson County have granted L. W. Healy and others of the East Liverpool Railway, a franchise to build a road from Empire, this county, to the Jefferson County line. From East Liverpool the Healy lines will be built to Beaver, and Wheeling and Pittsburg will be connected by an electric line. There is a line from Wheeling to Empire now.

INDIANAPOLIS, IND.—It is announced at the office of the Indianapolis & Martinsville Rapid Transit Company that the work of grading the extension of the line from Martinsville to Bloomington will begin as soon as the frost is out of the ground next spring. The right of way has been secured, and at present the management of the road is attending to the final details.

ARKANSAS CITY, KAN.—The Kansas-Oklahoma Interurban Railway Company has begun its permanent survey and announces that the actual work of grading the line from this city to the Chilocco Indian school in Oklahoma will begin within thirty days. The construction of this part of the road will be followed at once by the construction of the line between this place and Winfield.

GUTHRIE, OKLA.—The city council, at a special meeting, passed an ordinance granting to John Shartel a new franchise to construct a street railway in the city of Guthrie. The new franchise contains several amendments and provides that work upon the street railway shall begin within thirty days, and that four and one-half miles of street railway shall be built and in operation on or before the first of May, 1905.

CARTHAGE, MO.—A. H. Rogers, E. Z. Wallower and A. G. Knisely have sold to the Southwest Missouri Electric Railway Company the line known as the Chitwood branch, extending from First and Main streets in Joplin to Chitwood. Also the same parties sold to the company the Duenweg branch, extending from Prosperity to Duenweg. The consideration for the two branches was $91,000. They also sold to the Southwest Missouri company the line extending from Main and Second streets in Joplin to a connection with the Chitwood branch for $30,000.

CUMBERLAND, MD.—A certificate of incorporation has been granted a company to operate a passenger railway from Cumberland to Mount Savage, from Corrigansville to Ellerslie and from Barrellville to the Pennsylvania state line, a distance of less than twelve miles. The capital stock is $50,000. The incorporators and directors are George Clinton Uhl, Mount Savage; Dr. William Oliver McLane, Frostburg; John Henry Holzshu, James A. McHenry and Charles G. Holzshu. It is understood that it will cost about $150,000 to build the proposed line. James A. McHenry and J. Henry Holzshu are officials of the Cumberland Electric Railway.

ROCHESTER, N. Y.—The grading on the Rochester, Syracuse & Eastern Railroad is progressing rapidly. Between Macedon and Palmyra, a distance of three miles, the work is completed, making six miles finished on that section of the road. Between Rochester and Fairport two and a half miles have been finished. Work has also been started on sections four and five between Palmyra and Lyons. Most of this will be steam shovel work and will be carried on all winter. Considerable progress has been made on the bridges along the sections where grading is being done. The abutments are up for the bridge across Ganargua creek at Palmyra. This will be a 100-foot span. The abutments are also up for the bridge across Thomas creek and for the one across Irondequoit creek.

WOONSOCKET, R. I.—It is stated that the plan for a short electric railway from Worcester to Providence, which would pass through Millbury, Sutton, Manchaug, Douglas, Burrillville, North Smithfield, Smithfield and North Providence to Providence, is again being taken up, and that the line, double-tracked and only thirty-six miles long, as compared with the forty-four miles of the steam road, will be running in the summer of 1906. This is the road which has been called the Douglas pike line. It would cross the Woonsocket-Pascoag trolley and steam lines near Nasonville and its nearest point to Woonsocket would be in the vicinity of Primrose, four miles southwest. Fifty cents fare and a running time of less than two hours between Worcester and Providence are promised.

KALISPELL, MONT.—An organization of the Flathead Valley Railway Company has been effected. Contingent upon the support of the residents of Kalispell and the farmers and lumber interests of the Flathead valley, the company proposes to build a system of electric lines radiating from Kalispell into all parts of the valley. The special committee preparing the articles of incorporation made its final report, and the articles were unanimously adopted. They provide for a capital stock of $500,000 in $100 shares, which will provide for the construction of sixty miles of completed railway, including telegraph lines. It is probable that the first construction to be undertaken will be toward the north and northwest of Kalispell in the Spring Prairie neighborhood, on the east side of Montford and Lake Blaine. Those sections have no transportation facilities. Construction is planned to continue, however, on all the lines until connection is made with the Great Northern on the north and Flathead lake on the south.

ELECTRIC LIGHTING.

FAIRMONT, NEB.—Arlington is to have a new electric light plant. It will cost $23,000.

ROCKFORD, ILL.—The Rockford Edison Company will install two new boilers at a cost of $10,000.

EAST LIVERPOOL, OHIO—Plans are under way for doubling of the capacity of the Wellsville light plant.

NEZ PERCE, IDA.—The Nez Perce Power Company is installing a new seventy-five-horse-power steam engine.

NORTH TONAWANDA, N. Y.—The city will hold a special election to vote on the question of municipal lighting.

CORVALLIS, ORE.—All arrangements have been completed for the installation of an electric light system at Philomath.

LOCKPORT, N. Y.—The Niagara, Lockport & Ontario Power Company is planning to erect a $100,000 transformer house.

UPLAND, PA.—A company will be organized shortly to install an electric light plant. Louis R. Page is promoting the enterprise.

BELLEFONTAINE, OHIO—The municipal electric light plant of this city is out of repair and the city officials are considering a proposition to sell it.

DULUTH, MINN.—A new dynamo and switchboard have been installed at the light plant. The cost of the improvements made aggregates $10,000.

LAFAYETTE, COL.—The Lafayette-Louisville Electric Company, which has been operating in both towns about nine years, has sold its business to the Consumers' Electric Company for a consideration of $14,000.

MANITOWOC, WIS.—The West Side Lighting and Power Company, which was recently granted an ordinance by the council for an electric plant, has submitted a new one, asking the privilege of furnishing power and heat.

CLIFTON SPRINGS, N. Y.—Work has been commenced on the new municipal electric light building. The main building is to be forty-two by fifty-two feet, eighteen feet high. The contractors expect to have it completed in about sixty days.

HARRISBURG, PA.—The contract for lighting Capitol Hill and furnishing electric power for the coming year has been awarded to the Harrisburg Light, Heat and Power Company at its bid of $26,400 by the board of public grounds and buildings.

NEWBURYPORT, MASS.—The annual report of the Newburyport Gas and Electric Company, as filed with the state board of gas and electric light commissioners, shows total assets of $269,291.92, and liabilities of $250,211.05, leaving a balance of $19,080.87.

BRAZIL, IND.—The Terre Haute Electric Company will shortly begin work on a new freight depot. The company will also rebuild the lines in this city. The old poles will be replaced by new and higher ones and several miles of new wire will be strung. Some improvements are to be made at the power plant.

WASHINGTON, N. J.—The common council has entered into a two-year contract with the Washington Electric Light Company. The rate paid is $60 per arc light and $15 per tweny-four-candle incandescent light on the moonlight schedule. There are forty-seven arc lights and thirty-seven incandescents and the whole totals $3,300 a year.

ONEIDA, N. Y.—The directors of the Madison County Gas and Electric Company, recently elected, have organized by electing officers as follows: president, C. Wellington Koiner, of this city: vice-president, Isaac C. Greene, of Providence, R. I.; treasurer, Frank D. Pavey, of New York; finance committee, Messrs. Pavey, Greene and Allen P. Stevens, of Providence, R. I. The retiring president is Lawrence Barnum, of New York.

KINGSTON, ONTARIO—The city, on the recommendation of the fire and light committee, has directed the preparation of a by-law which will authorize the raising of $150,000 with which to improve the gas and electric light plants. The demand is steady for a service which the city can not grant until the gas mains have been extended and provision has been made for carrying the electric energy generated to the limits of the city.

COLUMBIA, S. C.—The Oconee River Water, Light and Power Company, incorporated at Walhalla with a nominal capital stock of $125,000, will develop about 700 horse-power at a point seven miles from Walhalla, and transmit energy by electricity to that town and its vicinity. New York capital will be largely interested. The incorporators are James Thompson and William J. Striblong of Walhalla, and W. B. Frink, of New York.

NEVADA, IOWA—The town of Story City in the north part of the county has entered into a contract which will eventually end in the purchase of the electric light plant by the city. The plant was originally built at a cost of about $7,500. The city has now leased the plant under a contract by which it is to furnish light to the stockholders until they are repaid for the money advanced by them, after which the plant will become the property of the city.

YORK, PA.—The city council recently approved the Edison Electric Light Company's contract for lighting the city streets during the year 1905. According to the terms of the contract the city will pay thirteen and one-half cents per light per night for 365 or more arc lamps, similar or superior to the ones now in use; but no lamps that are out of service for more than three hours in one night will be paid for. The agreement runs for five years, beginning the first Monday of April, 1905.

CLEVELAND, OHIO—The newly formed Cuyahoga Light and Power Company has introduced an ordinance into the council to serve the city and its inhabitants with light and power. The new company's capital is named at $25,000, and the incorporators are C. L. Denton, H. J. Caldwell, Abraham Lowenthal, E. Umbstatter and M. V. Little. The ordinance, as introduced, gives the company permission to erect poles and wires, underground conduits and other fixtures in the streets of Cleveland to furnish light and power. Prices are not mentioned. The city, by the terms of the ordinance, may purchase the plant at any time or grant any other company the joint use of fixtures and poles on a pro rata basis. If the city wishes to purchase, the price is to be determined by arbitration.

SEATTLE, WASH.—The ordinance directing the board of public works to purchase from the Seattle Electric Company its street lighting circuits has been unanimously passed by the city council. The ordinance authorizes the board to expend the sum of $52,743.73 for the Electric Company's holdings. Of this amount $48,018.51 is to be used for the purchase of the wires, arc and incandescent lamps in use on the streets, pole pins and insulators, and the transformer switchboard now in use by the company at its Post street station. The remainder, $4,735.22, is to be used for the purchase of the supplies for the street circuits which the company has on hand. As soon as the substation is completed the transformer and switchboard will be removed from the Electric Company's station to the city station and installed.

ALBANY, N. Y.—The St. Lawrence Transmission Company has been incorporated with the secretary of state, to generate, buy, sell, transmit, use and deal in electricity for producing light, heat or power; also to carry on the business of lighting by electricity or using it for heat or power in various localities. The capital stock is $25,000, in shares of $100 each. It is proposed to carry on operations in the towns of Massena, Louisville, Norfolk, Waddington and other towns, and in the villages of Massena and Waddington, Madrid, Norwood, Potsdam, Canton, Rensselaer Falls, Heuvelton, Hermon, Morristown, Gouverneur, Edwards and Talcville and the city of Ogdensburg, all in St. Lawrence County, and the towns of Antwerp, Theresa, Alexandria, Philadelphia, Leroy, Parmelia and Watertown, the villages of Antwerp, Theresa, Redwood, Alexandria Bay and Philadelphia and the city of Watertown, all in Jefferson County.

TORONTO, ONTARIO—Plans are being made to utilize the water power of the Credit river for the purpose of supplying electric light and power to Toronto and Toronto Junction. The scheme is to tunnel, during the present winter, from the dam, under Dundas street, and under the village of Erindale, a distance of 900 feet. The opening to this tunnel will be eighteen feet below the level of the water in the dam, and will have a head of thirty feet where it comes out on the other side of the hill. It is here the machinery for generating the power will be placed. Gates will be placed at each end of the tunnel, so that the water can be let out and the tunnel repaired when necessary. The tunnel will be built of brick and concrete. J. Barrett has purchased the property on both sides of the river, and all the land that will be flooded by the dam, which is now arable land. The cost of the scheme will be $250,000. About 20,000 to 50,000 horse-power will be generated.